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# **Project Management**

Project management plays a pivotal role towards projects completion. It entails various essential components such as monitoring, controlling, learning, evaluation, organization, and planning. Importantly, project management incorporates a vital aspect otherwise known as project scope which consists time, budget, natural environment, social environment, and quality. Within the industry context, project managers interact with a plethora of fields, deal with unique projects, complicated designs, and implement various projects in high political, social, and environment areas (San et al., 2018). Managers often work under immense pressure, high cost operations with minimal profits, sophistication, high levels of uncertainty, conflict and ligation, and turnover. Sectors that mostly seek the services of project managers include commercial, infrastructure, residential, industrial contractors, and heavy construction. Affiliated institutions comprise suppliers, professional services, and financial services.

Recurrent themes in industrial project management exhibit the following features: performance, incentive, conflict, uncertainty and risk, flexibility, important roles of quantitative and qualitative factors. A successful project engages various stakeholders such as owner, designer, contractors (Armenia et al., 2019). The owner’s responsibilities include commissioning the entire project and arranging financing. Some of the common motives entail good workmanship, save funds, and hasty completion of the project. The designer otherwise known as engineers and architects are responsible for drawing designs of the facility, provide oversight role during the construction process. Some of the common motives include ensures client satisfaction and recognition which in turn attributes to future referrals. Contractors often play crucial role individual and industrial projects. Their responsibilities include designing and building facilities. Similarly, contractors’ common motives ensure quick completion of projects and overall customer satisfaction.

Survey of construction phases comprises feasibility analysis, design, development, closeout, operations, divestment, and system project management, and managing commodity development process. For any project to post successful results, project stakeholders conduct feasibility studies and preliminaries. They do so to comprehend project evaluation and finance; this assists in understanding economic setbacks experienced by contractors and the owner. Similarly, it helps in understanding imminent threats and intends to manage risks. This introduces project stakeholders to risk premiums, making crucial decisions under intense uncertainties, weigh on available incentives, and risk management. Feasibility studies also help project professionals to decide on important factors of the contract such as the delivery type, contract type, award method, and conditions (Stanitsas, Kirytopoulos & Leopoulos, 2021). Additionally, project assessment and financing is associated with essential components such as financing mechanisms which is available in different forms such as private, public, and hybrid funding. Similarly, assessment measures include cost-effective and cost-benefit examination. Project evaluation ensures value for money, discounted cash flow assessment, and present value.

# **Risk Analysis**

Risk analysis incorporates crucial elements such as risk management which pinpoints, classifies, and mitigates risks. The basics of decision assessment mostly utilize decision trees to conduct effective and efficient examination. Additionally, risk analysis employs important preferences and concepts, risk attitude, and the root of risk in the construction process. Importantly, the delivery, award, and contract contain important aspects that guide stakeholders on different delivery ways, award mechanism, contract type which demonstrates methods of payment, and contract design that lays risk sharing, scope definition, dispute resolution, and tips to prevent avoidable claims and safeguard contracts (Hugo, Pretorius & Benade, 2018). Projects adopt claims and changes control to minimize degree of damage in case it occurs, dispute resolution to manage conflicts, conflict escalation in case aggrieved parties need compensation, actions to undertake in case claims delay, and on call contractors available to conduct designs of various projects (Shishodia, Dixit & Verma, 2018). Claims and changes control acts as an important aspect towards claim resolution.

# **Project Funding**

 An owner of a project finances his or her projects through private, public, and joint-venture financing. He or she sources financing via public financing that constitute from capital grants, general purpose, international loans, capital grants, and tax revenues. Nonetheless, public owners experience finance limitation from various avenues such as bonding caps. Public funding is mostly provided to solve social and economic challenges (Hair & Sarstedt, 2021). They are meant to benefit a given area or region, provide unemployment relief, and improve the quality of life to the citizens. A significant percentage of public projects often receive tax exemption. Private financing mostly involves debt in form of retained earnings, borrow money, and bonds.

Additionally, project owners engage equity shares such as stock issuance. It involves wooing investors with high rate of returns. Private owners often engage collateral facility during different financing phase’s normally long and short term. The long-term collateral focuses on financing debts and operations. They exhibit common features such as low interest rates and paid in project revenues and tax revenues. Short-term also described as constructive period demonstrates borrowed money that the project owner can pay for construction, it risks, capital intensive, and incomplete collateral (Zemlyak et al., 2019). It is important to state that majority of such loans are negotiated as a package. Lenders seek funds from investment banks, insurance companies, and savings and loan. Project owners can implement innovative alternatives such as seeking funds from the contractors. Importantly, the lender conducts risk assessment. Funds borrowing exhibit general requirements such as capacity, character, and collateral.

 The primary reason for documentation purposes during borrowing is for the lending institution to ensure that the borrower can service the loan. Some of documentation examples include cost estimates, retained earnings, financial statements from sources of income, a filled pro-form, and market assessment to show estimated income. A lending institution often funds joint ventures particularly large scale projects. Some of the advantages of issuing loans to special companies include restricted risks, subsidized agency costs, and tax exemptions. Contractor financing includes subdividing payment schedule. Some of the activities that occur in the payment schedule entail architect certify project progress, a unique kind of compromise between the owner and contractor, and dividing payments into components. Additionally, contractor applies for payments which mostly are more than the total cost. Similarly, the schedule does not equipment costs which may be multiple months prior before payment. Contrary, the project owner focuses on unbalanced bids and front-end loaded bids in the contractor financing II. This alternative allows for numerous borrowing from lending institutions such as banks and reserve.

Additionally, some project owners may also help in funding. Conversely, a project owner demonstrates favorable terms in borrowing such as size, collateral, and stability especially for contractor financing III. This type of financing demonstrates 3-way agreements mostly between owner, contractor, and bank. Financial institutions issue payments to a contractor depending on the progress of the project. Contractor funding IV displays the following schedule of values such as the entire frame work of payments, owner’s assessment, and recent innovation, relies on Maserformat breakdown structure, and restricts explicit payment systems. Similarly, a significant percentage of lenders borrow money primarily due to delays in payments (Ramsey & Jones, 2019). Several stakeholders in project management lower costs during difficult financial periods. They comprise contractors, suppliers, and manufacturers.

# **Money Worth**

 The value of money always increases when invested wisely. For instance, a person may opt to store the money in the bank and gain interest later. Similarly, other individual choses to start a business and gain profit from purchasing and selling products. However, money deposited in a bank loses value due to the time spent in various financial institutions. Money in the present is said to be unequal to a larger sum of money in the future primarily due to inflation. The net present value (NPV) refers to current values for all revenues and costs (Joseph & Marnewick, 2018). Economists advise investors to treat revenues as positive outcomes and expenses as negative. NPV specifies cash values even beyond the profits gained in case the revenues were from investing expenses.

Computing Present Value (PV) connotes benefits and costs gained from subsidizing members in a cash flow system. This is attributed to the increasing value of investing or borrowing from reliable lending institutions which in turn sporadically rise. This perspective is implemented via preference of discount and applying for discounts. Any individual project is worthwhile given that it guarantees the highest returns on capital investments that correspond with the risk taken. Therefore, investors can examine their projects against opportunity costs. NPV is used to calculate alternative projects that can yield better outcomes compared to the risk incurred (Joseph & Marnewick, 2018). Some of the factors that investors need to take into account include the minimum attractive rate of return (MARR) which translates to the minimum amount of discount accepted within multiple markets which matches the risks linked to the project.

 Business persons need to consider internal rate of return (IRR). It acts as a tool to analyze the rate of return of investment. For instance, it geometrically evaluates the rising series of different values. Occasionally, NPV and IRR provide similar outputs among different projects. Interesting, IRR neither needs to compute nor assume discount rates. IRR focuses on the rate of gains but not the size of the gain. IRR displays same characteristics in payment; it assumes the usual payment lifecycle (Joseph & Marnewick, 2018). Although money is a crucial element in easing daily operations, most people over see its benefits. Social benefits are more important. For example, interactions with close friends and family members offer the best results as it uplifts the feelings and moods of people. Nonetheless, money offers a myriad of gains to the populace. Funds are used to build educational institutions, health facilities, and employment opportunities. Similarly, it presents intangible benefits such as a new cafeteria and fosters strategic benefits. It contributes long term partnerships with business partners.

 Critical uncertainties derail revenue such as the length of the project, level of occupancy, post-construction revenue, and cost of projects. Costs especially construction costs accompanied by uncertainties such as labor costs, environmental conditions, fluctuating interest rates, and size of the lowest bid. Additionally, maintenance costs such as energy costs, wear and tear of equipment, and labor costs (Joseph & Marnewick, 2018). The ever increasing energy costs increases the cost of production that in turn determines the overall price of products. Thus, the uncertainties determine the existence or closure of a given business in the market.

# **Role of Decision Trees in Decision-making**

 Decision trees are important elements in assisting businesspersons in decision making especially in risk. Importantly, decision trees represent uncertainty. Some of the notable examples of simple decision trees include attitude, risk preference, and premiums. Decision trees are mostly employed for evaluation purposes. Similarly, they are used to represent flow time, uncertainties (events), decisions, and consequences. People share similarities with uncertainty. Thus, lack of indifferences from different levels of uncertainty results to uneven preferences for diverse results. People vary especially in comfort especially on preferences and circumstances (García, Segovia & Pliego, 2019). Shrewd businesspersons will purchase risk premiums to prevent uncertainty. Risk attitudes are divided into distinct classifications. Risk averse, neutral, and lovers. Risk adverse individuals fear for losses and always seek for guaranteed gains. Risk neutral people are hopeful while risk lovers expect to win. Essentially, risk attitudes change with time and circumstance.

 A risk premium connotes to the entire amount money paid to prevent a certain risk. Risk premiums are undertaken occasionally in various forms such as insurance premiums, a contractor charges a higher charge, funds to maintain flexibility, and owner pays higher fees to contractor of a reputable company to complete the project. Decision trees act as instrumental examinational tools. Some of the notable evaluation strategies include strategy selection, information value, one-way or multiple analyses (García, Segovia & Pliego, 2019). Procurement timing is one classical example of interactive decision tree. It incorporates various elements such as events, decisions, consequences. Decisions entail order of time in terms of choice while events that compose arrival time and damage. Lastly, consequences represent cost such as storage cost, delay cost, and cost incurred during reorder.

# **Flexibility**

Flexibility refers to offering additional choices. Flexibility normally encompasses various components such as value and cost. Value acts as pivotal process to minimize negative outcomes attributed to uncertainty. Additionally, cost which involves extra time, delaying decision, and extra cost to enable flexibility. Multiple strategies exist to allow flexibility particularly construction. These ways include optional delivery, contingent plans for geotechnical conditions, value engineering, procurement strategy, alternative heating, wiring rooms, additional elevator, wiring to rooms, and sequential construction (García, Segovia & Pliego, 2019). An adaptive technique refers to a series of actions taken based on various observation strategies. Therefore, project managers opt to plan as events unfold instead of prior plans. Similarly, project professions employ real options hypothesis as a way of approximating financial value. For instance, engineers may choose to abandon a firm or expand its size primarily due to flexibility of financial value. Experts rely on NPV to calculate revenues or costs of certain activities. Moreover, they depend on stochastic differential equations such as analytic solutions to derive a decision-tree based structure.

 Building and designing experts utilize some considerations to ensure the integrity and success of their projects. Professionals consider tradeoffs which mostly are short-term and flexible. For instance, overlapping constructions and design may affect the integrity of the building. Similarly, architects and engineers adopt short-term flexibility and cost. For example, performing low cost but quality value engineering. Similarly, project owners often select low bidders to minimize the entire cost of the project (Harrison et al., 2018). However, late decisions often lead to increased project costs as the owner might employ skillful workers that demand higher compensation. Therefore, both scheduling and budgeting are important components in successful project completion.

# **Project Organization**

 Project organization entails a plethora of activities which if adhered to contributes to a successful project completion. It covers project delivery framework that accommodates essential systems such as design, construction management, construction management at danger, and traditional. Construction or building started in the early ages. Since the 15th century, the Western world had already made distinctions particularly among construction professionals. For example, architects had their unique roles and responsibilities; they focused on design of buildings (Gayathri & Suresh, 2018). The 18th century saw the rise of building engineering mostly subcontractors that often received bids to conduct small scale constructions. Majority of project owners in the 1930s construct design buildings mostly with optional financing methods. After World War II led to the emergence of specialized subcontracting and needs which allowed for the rise of more construction companies to build high rise building across Europe and America. Moreover, the 1960s and 1970s welcomed mechanization of building which contributed to design of sophisticated structures (Gayathri & Suresh, 2018).

 It necessitates the project owner to hire design experts such as architects and lawyer responsible for design preparation and signing of vital contract documents. Traditional delivery technique allows for negotiation or competitive bid process with contractors which occur mostly after design completion. The main contractor may opt to subcontract; however, he or she is solely responsible for completion of the work. The primary contractor is liable to law suits in case the project fails to meet the demands and needs of the project owner. Therefore, he or she subcontracts responsibly to avoid damages. The conventional delivery technique assumes collaborative relationship between project executors and owner. Similarly, it exhibits multiple stakeholders’ interests. For instance, the owner expects a quality product, site safety, and effective and efficient delivery schedule (Gayathri & Suresh, 2018). Additionally, the contractor aims for a positive reputation, profit, healthy relationships, and less construction time. Subcontractors also need an increased network and positive image.

# **General Contractors**

 General contractors are often liable to major responsibilities especially in public projects. In most cases, general contractors engage in disputes particularly between them and designers. Therefore, the project owner needs to mediate such conflicts whenever they occur. Moreover, the contractor is responsible for the construction of structures with the help of engineers. Contrary, subcontractors have distinct roles and responsibilities with the general contractor. For instance, they hand submittals, take responsibility whenever a project fails, head different fields, and purchase designs from other subcontractors. Project engineers or architects are recruited based on service, they engage in fierce design competition, negotiate for cost of design (Nicholas & Steyn, 2020). Some of the advantages of architects or engineers include; contractual protection, open bidding, non-interference particularly the project owner, and an enhanced fiduciary relationship between the owner and the subcontractor. Nonetheless, there are numerous disadvantages associated with assuming the engineering role. The designs are never reviewed prior construction. Therefore, the engineer incurs major costs and loses time. Similarly, liner and sequential process minimizes the opportunity to save money and time. Additionally, inhibits interactions with other stakeholders. Lastly, the project never commences if the design are incomplete.

# **Construction Management at Risk**

Construction management (CM) at risk guarantees maximum price therefore it guarantees the project owner that the entire project will be completed within the budget offered. Similarly, it lessens risks for the owner. Additionally, there exist contractual relationships between the subcontractors and construction managers. The advantages associated with CM at risk include minimized owner’s risk, the CM is guaranteed maximum price of the project. Additionally, fosters a contractual relationship between the trade contractors and CM. Nonetheless, there are disadvantages linked to CM at risk. The guaranteed maximum price is usually a defined cost for an undefined commodity. Tension as CM hire early contributed to increased cost of the entire project while CM hired later leads to decreased value particularly during the design phase.

# **Quality Assurance**

Quality assurance is usually process-oriented. Retrospective quality feedback examines the overall standards of work units. On the contrary, process-oriented reviews are conducted within a firm to assess the activities that influence the nature of work delivered. Team building and knowledge transfer act as vital elements towards the success of an organization. Successful companies incorporate learning and highlight the importance of team building to their staff to ensure efficiency, customer retention, skyrocketing revenues, and client loyalty.

# **Value Engineering**

Value engineering refers to quantifying and pinpointing the performance of designated systems installed within a specified facility. Similarly, it entails examining the gains and expenses of alternative solutions. Specifically, it is a process that identifies solutions that accomplish better outcomes and lower operational costs. Reviews serve as pivotal elements due to two attributing factors: unpredictability within the construction industry and desire for collaboration and intensive communication.

# **Constructability Reviews**

The majority of contractors share similar beliefs that numerous challenges arising in a project, such as technical problems, delays, conflicts, and scheduling problems, are attributed to engineers or architects' failure to consider ways that the building contractor will implement the unique designs. Specifically, the difficulties manifest in various forms, such as pending specifications, faulty designs, sophisticated contract language, and complicated designs. Therefore, constructability reviews serve as critical aspects in closing the gap among construction professionals. The primary reason for incorporating constructability reviews is to solve challenges in a construction project.

# **Project Audits and Financial Management**

 Project audits and financial management are distinct entities. Project audits concentrate on the impact of a project on the firm. Contrary, management audits assess a company's management effectiveness. Furthermore, project and financial audits share examination and process procedures. Nonetheless, they concentrate on different aspects; project audits solely focus on financial performance, duration of the project, and the overall expenditures. Firms encompass financial audits to safeguard their assets. The scale of a project audit is usually broader than a limited range of financial audits. Project managers often seek audit services for a detailed and unbiased report from their respective organizations. Similarly, organizations use audit checks to pinpoint current errors, implement a follow-up to identify the causes and incorporate measures to prevent future reoccurrence. Additionally, external stakeholders require audit services to ensure donated finances are used appropriately.

# **Existing Data**

 Existing data is located in project files either in paper form or electronically. It is usually available for audit purposes. Existing information is categorized differently; it comprises customer needs, cost performance, schedule, relevant constraints, work Breakdown Structure (WBS), Organizational Breakdown Structure (OBS), communication logs, and risk allowance. Derived data is available for compilation, synthesis, and interpretation purposes. Companies usually use data extraction instruments such as interviews, questionnaires, and workshops. However, these tools are susceptible to prejudice and biasness.

# **Essentials of a Project Audit**

 Project audit comprises two distinct processes: incorporating essential lessons for a project team and lesson generation. Vital recipes for a successful learning process include audit report circulation, audit team, audit transparency, mutual communication, easy accessibility to project orders, and sensitive matters that need to be sorted within the organization. Fruitful communication among the administrative staff and audit team ensures transparency, particularly in the financial books. Accountants develop a project audit after successfully conducting an audit. Some of the critical components of a report include an introduction, current audit status, future projection, risk assessment, recommendations, assumptions, and limitations.

# **In-depth Estimation and Pump station Summary**

Estimation is described as an art as opposed to a science. The art of quantifying estimates is possible; however, it is complex it is trade-oriented or method-specific. Similarly, it greatly relies on the subcontractor estimates'. Moreover, detailed estimation rarely translates to accuracy. Sophistication in estimation is categorized into two main components: system complexity and detail complexity.

# **Project Organization**

 Project organization integrates important components into two main parts: estimation and detailed estimation. These two main parts are further subdivided into other categories of analysis, such as introduction and conceptual assessment, containing vital components, specifically cost indices, parameter costs, component ratios, and cost-capacity factors—similarly, the detailed estimation such as labor costs approximations, quantity takeoff, and probabilistic strategies.

# **Contractor's Bid approximations**

A contractor usually bids low to win tenders, yet the expert typically makes enormous profits. Usually, contractors depend on intuition, past productivity, and quantity takeoff. Occasionally, contractors provide less detailed bids compared to their fair-cost approximations. Nonetheless, the construction experts usually apply definite estimates to foresee the outcome of the final project expenses, often with a bit of margin of error. Nevertheless, the error can be solved by including an already-examined contingency. Four classifications were used to review definite approximations design-build, traditional, unit price, and professional CM. Standard definitive estimations assure maximum price and costs. Notably, a final estimate requires subcontractor quotes, in-depth specifications and projects, prices for main facilities, and material quotations.

# **Definitive Estimates**

 Definitive measures are conducted simultaneously when a guaranteed maximum is prepared, usually under the traditional perspective. For instance, it is possible to create definitive approximations after a comprehensive design is approximately 95% before completion. Definite estimates incorporate unit prices employed in large-scale projects such as highways, dams, airports, and tunnels. However, quantities may exceed or be underestimated due to many reasons such as excavation, other foundations, and poor soil conditions. With limited geological information, the project's overall cost is unpredictable until the completion of a given project.

Similarly, quantity takeoff comprises vital elements that guarantee a successful project. For example, systematic identification of work and building materials encompass critical key features that showcase distinct characteristics as exhaustive and mutually exclusive. Quantity takeoff is employed to calculate the labor amount of building material and ensure the utilization of material equipment.

# **Labor Price Estimation**

 It entails vital components such as wages, wage premiums, social security, fringe benefits, insurance, and unemployment tax. Wage premiums include overtime, shift work, and arduous work. Shifts are modified in hours while overtime considers some professionals that work for over 32 hours. Similarly, the hazardous job entails robust crane, underground work such as mines, and working on swinging gibbets. Labor productivity estimation is sophisticated yet essential; primarily, it determines qualitative factors such as learning, environment, fatigue, and morale.

Similarly, it is used in determining historical data in various quotas such as professional organizations, departments of labor, and state governments. Productivity considerations consider primary factors such as learning curves, location of the workstation, work schedule, the weather, worksite rules, and management style. Successive approximations contribute to reasonable total project estimates. It adopts a top-down strategy to make rapid approximations. Similarly, it pinpoints irreducible uncertainty and expected variance and value.

# **Simulation Techniques**

 Static scheduling guarantees prior project preparation as scheduled before time to enable a coordinated approach between subcontractors and stakeholders. Additionally, the reservation system enhances coordination since it is pre-planned. Contrary, dynamic scheduling allows for queuing since coordination consumes time; however, both approaches ensure project success.

# **Granularity of Scheduling**

 It boosts crew productivity, calculates distances traveled for specific crew members, and ensures work-life balance. Additionally, scheduling granularity is associated with some benefits, such as building creativity and easing combinatorial. Primary kinds of simulation include project-scanning techniques that determine stroboscope and cyclone. Additionally, transaction-based tactics were used to determine GPSS and SLAM.

# **GERT Basics**

It relies on Activity-on-Arrow maps. Discrete semantics depends on transactions flow and fire off. Importantly, transactions safeguard resources for processing purposes. Nonetheless, stakeholders need to wait until the availability of resources. Similarly, GERT Basics display probabilistic features used to loop, branch, and durations. Additionally, GERT node kinds comprise source nodes, statistics nodes, mark nodes, and diversity types. Q-GERT is employed to deliver outgoing activities, accumulate units in a project, combines transactions, and develop SLAM and GASP. GERT applications are used in Alaska pipelines, offshore oil rigs, and reservoir construction. Construction simulation languages are sophisticated and powerful. Any of the languages correspond to each other. However, they are distinct due to various reasons such as extensibility, user-friendliness, and expressive.

# **Process Interaction Structures**

Some of the examples include ModelSim, ProModel, SLAM, and SimScript. It depends on transaction flow along with the system. They are also applicable in workstations that rely on clearing systems with the assistance of a system. Nonetheless, process interaction experiences some setbacks. For example, it is challenging to determine aspects that constitute transactions. Similarly, it is challenging to modify other entities in a project. Lastly, the project risks a deadlock, particularly over available resources in simulations.

# **Activity Scanning**

It represents similar activities, particularly in cycle diagrams. Identify better conditions necessary for resource completion. Similarly, it is construction-specific as it employs STROBOSCOPE AND CYCLONE.

# **Steps of Network Techniques**

Network strategies approximate resources and time allocated for every activity. Similarly, it estimates resource usage, cost, and time within a project. If acceptable, this technique allows for project termination. Likewise, if not sufficient, project stakeholders advise reducing resources or imposing dependencies. One of the most vital aspects of a project is human resources since it determines its success. Therefore, it consumes time to procure human resources, is challenging to recycle and is complex to release. Similarly, the equipment acts as a pivotal tool towards proper project completion. However, sophisticated equipment requires highly trained staff that demands hefty wages. Nonetheless, a project site also uses user-friendly equipment that is easy to use. However, some challenges exist, such as obtaining a permit from the local authorities.

# **Resource Algorithms**

Resource algorithms comprise several components to guarantee their efficiency and effectiveness. It is classified into two main features: resource leveling and resource scheduling. Resource leveling controls activities in motion to limit fluctuation rates, particularly vital human resources elements, whereas resource scheduling specializes in fixing resources within the project's timelines within limited extension deadlines. Leveling strategies comprise combinatorial problem which is expensive to complete. Principally, it requires an expert to distinguish every order that conflicts with each other. Similarly, scheduling techniques rely on intuition since it commences and halts due to project-related setbacks. Essentially, it adopts several approaches to guarantee accurate results. Some of the applications employed include explicit enumeration, linear programming, and constrained search.

# **Bidding**

Contractors engage in bidding to win project tenders. Most contractors place low bids, which involves employing multiple-parameter bidding. Project contractors arrive at low requests using arithmetic combination and dividing bids by ranking other essential aspects. However, placing low bids fails to guarantee sure wins; it is a win or loses venture. Contractors often place lump sum bids to ensure success. Bidding is associated with many benefits such as transparent engagements, high profits, comprehensive strategies, and approved regulatory systems. Nonetheless, bidding is also linked with several setbacks. For example, it is a win or loses activity, limited consideration to designing before pricing, low bidders are primarily unreliable, low bids attract minor profits, which in turn cause low morale, and hiring low-skilled staff.

# **Bidding Process**

First, it involves making the bid public, further specifying qualification criteria, secondly, submitting bid documents. For example, interest parties must provide sample contracts, supplemental provisions, fair cost approximations, and drawings and specifications. Thirdly, in the pre-bid conference, the bidders explain the working conditions, expound the scope, and answer crucial questions.

# **Qualifications**

Some of the common items required for qualifications include safety record, bonds, licensing, positive reputation, financial muscle, interest, management system, and extensive experience in the labor market.

# **Public versus Private Bidding**

The government directs that public bidding must be publicly announced via posters and newspapers. Similarly, qualification usually happens after bid submission, mainly within a 60-day window. Contrary, private bidding is typically on an invitational basis. Qualification happens before bid submission. Contractors often develop measures to counter unrealistic low bids. Major stakeholders avoid ridiculous low price bids since they potentially risk the outcome of a given project. Additionally, low offers are characterized by high default rates as insurance firms typically avoid low bidders since they are vulnerable to maximum damages.

# **Subcontracting Bid Issues**

 General contractors often request bids from interest subcontractors. Mostly, general contractors lobby for the lowest price bids; however, they are not forced to follow a specific subcontractor. Nonetheless, such predicaments attribute to grave predatory behavior such as bid peddling and bid shopping.

# **Negotiation**

 Negotiation is primarily based on qualifications and a positive image. It is employed in two primary forms sophisticated and straightforward. It demands a savvy owner available to examine proposals and assess performance. A win-win scenario characterizes negotiation considerations contributed by distinctions in relative and risk preferences. The principle goal is to find a neutral ground for optimal agreement. Negotiation requires a negotiator to remain within the price scope; avoid over quoting, discuss numerous issues once, have formal exposure, incorporate an objective position to prevent disputes. Negotiation experts advise upcoming negotiators to avoid settling for less, rejecting favorable terms, failure to pinpoint win-win chances, and settling for unfavorable terms yet abandoning promising alternatives.

# **Parameter Costs**

 Parameter costs are employed in building sites. It showcases various features such as a warehouse, costs that reflect the actual size of the project, and reputable historical records that provide reasonable prices.

# **Project Management and System Thinking**

 The primary assessment exhibits several characteristics: local attention, fragmentation, extreme dependence, willingness, and hesitation. Some of the primary contributors to a project are planning, learning, and control. A project encompasses system dynamics that show a series of equations such as numerical integration, special handling, and state equation. Similarly, a project relies on a graphical representation to determine intermediate computations such as table functions and auxiliaries.

# **Ways Systemic Dynamic Perspective is created**

First, it relies on a causal loop to create a conceptualized diagram. Secondly, it converts causal loop construction (CLD) to state and modifies variables such as stocks. Combine equations to determine relationships. Standardize past data. Lastly, commence scenarios to pinpoint results.

# **Techniques to apply a systemic Dynamics Perspective**

First, assume a baseline scenario. Second, perform a policy scenario assessment. For instance, contractors can adjust a recruiting policy and later examine the impact. Third, policy scope uncertainty; investigate the effects of primary causals of uncertainty. Fourth, sensitivity examination to help in data collection. Fifth, assess the impact of distinct external conditions.

# **Uncertainties in System Dynamics**

Sensitivity analysis is commonly used to solve uncertainty problems. The primary goal is to determine the extent to which choices rely on uncertainty. Monte-Carlo trial is also employed to perform a comprehensive analysis. Essentially, there are two kinds of uncertainty, namely dynamic and static uncertainty.

# **Construction-related Model**

This model was founded by Park and Pena-Mora that incorporates essential aspects of network-based techniques. It is employed to examine real-life projects. Similarly, the construction-oriented method encompasses various components such as a robust series of dependencies classified into internal or external linkages and dependencies between construction and design acts.

# **Role of Quality**

 The disablement process model (DPM) defines quality as acceptable standards performed according to verified specifications. Statistically, better quality translates to increased costs and timeline completion. Dynamically, quality acts as a driver for modifications and rework. Softwares eases rework. However, revamping is costly and causes delays. Specification changes incorporate multiple types of changes, such as unintended and managerial modifications. It is pivotal to note that quality directly impacts costs and duration. Indirect savings from top-notch work outweigh extra charges. Changes have a direct impact on a project despite up-front payments.

# **Specification Modifications versus Rework in Construction**

Rework is short-term, mainly if a delay is caused when ascertaining original divergence. Additionally, it restricts the scope of impacts. Similarly, rework causes specification adjustments that often attribute to a myriad of side effects and are short-term in nature. Some examples in change propagation include disputes in drawings that often contribute to modifications to accommodate ductwork modification. It causes re-routing electrical, and plumbing, demand for heating, ventilation, and air conditioning (HVAC) requires assessment of the structure of a building, re-assessment of an electrical system, reconsideration of a piping system, and re-designing shop drawings. Nonetheless, delays adversely affect customer relationships, increase pressure to complete work, and idle resources.

# **System Dynamics versus Process Simulation**

Process simulation assumes a bottom-up approach, whereas systemic dynamics simulations adopt a top-down model. Process simulation examines a specific aspect of a given project while system dynamics incorporates soft components. For example, it deals with rough approximations when necessary. Process simulations base their assumptions on discrete event simulations. Contrary, the system dynamics is founded on stochastic differential equation (SDE). Systemic dynamics involve soft aspects such as fatigue or morale whereas systemic dynamic simulations adopt transparency measures to accommodate project learning or institutional knowledge. Some of the critical differences between the two concepts include precision versus accuracy, the strength of modeling versus the ease of establishing an implementable framework. Additionally, overall modeling versus a specified venture. Lastly, a forecast modeling versus a comprehensible model.

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# **References**

Armenia, S., Dangelico, R. M., Nonino, F., & Pompei, A. (2019). Sustainable project management: A conceptualization-oriented review and a framework proposal for future studies. *Sustainability*, *11*(9), 2664.

García Márquez, F. P., Segovia Ramírez, I., & Pliego Marugán, A. (2019). Decision making using logical decision tree and binary decision diagrams: a real case study of wind turbine manufacturing. *Energies*, *12*(9), 1753.

Gayathri, K., & Suresh, M. (2018). Modelling the factors of agile practices in project management: a case of illumination project organization. *Int J Eng Technol (UAE)*, *7*(2.33), 541-547.

Hair, J. F., & Sarstedt, M. (2021). Explanation plus prediction—The logical focus of project management research. *Project Management Journal*, *52*(4), 319-322.

Harrison, P. A., Dunford, R., Barton, D. N., Kelemen, E., Martín-López, B., Norton, L., ... & Zulian, G. (2018). Selecting methods for ecosystem service assessment: A decision tree approach. *Ecosystem Services*, *29*, 481-498.

Hugo, F. D., Pretorius, L., & Benade, S. J. (2018). Some aspects of the use and usefulness of quantitative risk analysis tools in project management. *South African Journal of Industrial Engineering*, *29*(4), 116-128.

Joseph, N., & Marnewick, C. (2018). Investing in project management certification: Do organisations get their money’s worth?. *Information Technology and Management*, *19*(1), 51-74.

Nicholas, J. M., & Steyn, H. (2020). *Project management for engineering, business and technology*. Routledge.

Ramsey, M., & Jones, S. (2019). We Have the Team, We Have the Funding Opportunity, Now What? Best Practices, Tools & Resources to Support Large-Scale Proposals.

San Cristóbal, J. R., Carral, L., Diaz, E., Fraguela, J. A., & Iglesias, G. (2018). Complexity and project management: A general overview. *Complexity*, *2018*.

Shishodia, A., Dixit, V., & Verma, P. (2018). Project risk analysis based on project characteristics. *Benchmarking: An International Journal*.

Stanitsas, M., Kirytopoulos, K., & Leopoulos, V. (2021). Integrating sustainability indicators into project management: The case of construction industry. *Journal of Cleaner Production*, *279*, 123774.

Zemlyak, S. V., Sivakova, S. Y., Shelomentseva, M. V., & Popova, V. V. (2019). Contemporary models of government-backed venture project funding. *В сборнике: Proceedings of the External Challenges and Risks for Russia in the Context of the World Community’s Transition to Polycentrism: Economics, Finance and Business (ICEFB 2019) Сер.“Advances in Economics, Business and Management Research*, 150-153.