Final Synopsis

Human Factors affecting strategy and risk in complex projects – A system dynamics approach

Synopsis of the Research Proposal

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Ranchi

By

Sarojkant Singh

Under the Supervision of

Dr. Mridanish Jha

Research Supervisor

Associate Professor

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Introduction

As the nature of projects is evolving, due to influence of various factors complexity is being introduce. Projects by their very nature of interrelated parts are complex in nature and this complexity only increases with project size and scale. The PMBoK indicates project management domains as - Scope management, cost management, time management, quality management, risk management, stakeholder management, communications, HR management, Resource management.

Human factors research will be critical from this perspective of connecting the impact of such factors on project profitability and finances in the coming days. Despite these studies, the field of **project strategy** is relatively nascent. In fact we may say there is a lack of understanding about project strategy. This research aims at addressing the problem and attempts at proving an integrated view of project strategy which has human factors at its core.

Keeping the above in mind this thesis aims to compare the system driven factors and human factors driven factors. In this research we shall approach complexity generated due to feedback i.e dynamic complexity. System Dynamics approach has been used in various applications including project risk management. In this thesis we address the apply this method to bring forth a tool to use for the practitioners of project management.

Strategy

Much has been written about “Strategy” by various authors in various contexts. The word “strategy” therefore gets misplaced in context or tends to be loosely used. Though Porter introduced the word, Richard Rumelt in his book Good Strategy and Bad Strategy explains “what strategy is Not” (Rumelt, 2012). the word “strategy” some misuse it for goal setting, some for the big picture , some with success and some with standalone goal. Rumelt describes Strategy “as a coherent set of analyses, actions, policies and concepts as a response to high stake challenges” (Rumelt, 2012) introduces to the core of strategy , the hard nut or what he calls the kernel consisting

of : First a diagnosis, Second a guiding policy and Third a coherent set of actions to carry out the policy. Missing any part of the kernel leads us to the blind man and elephant situation.

Project Strategy

There is a fundamental difference when we talk about strategy for business and project strategy. Financial statements use the words “ongoing concern” for businesses. The words signify a long term view i.e over many years even decades. On other hands projects are temporal and with a definitive start and finish. This reference of time on strategy makes project strategy similar to military strategy. “Project Strategy- a missing link” traces the origin from Sun Tzu’s Art of war to Porter’s work and then elaborates how in competitive and non-competitive contexts competitive advantage may be understood in context of projects. He explains the creation of “value” in both contexts. The author then guides the meaning with (Mintzberg, 1987) Five P’s principle. discuss (Artto et al., 2008)- “ What is Project Strategy” . This work provides is a groundbreaking direction for understanding project strategy. The author highlights two dimensions on which project strategy depends and its success or failure is affected. Firstly, Degree of Independence and second number of stakeholders. On this basis he categorizes four categories of project strategies viz Innovative Leader, Obedient Servant, Strong Leader and Flexible Moderator.

Mintzberg’s parameters of strategy goal, plan, ploy and direction when reflected with Rumelt’s kernel of strategy we find an interesting definition of strategy which can lead us towards developing a theory of strategy. We emphasize here that novelty of this thesis is in addition to the knowledge in the theory of project strategy which has not been discussed elsewhere. Strategy originates in the mind of the general in the war field, however, the general usually has a counsel to vet and iron out his thoughts.

The term stakeholder has relatively recent origins in the 1960s. The word was first coined in Stanford Research Institute. In 1971 Hein Kross published (Schwab & Kroos, 1971) a booklet where they argue that for long term sustainability, not just shareholders but all stakeholders must be served by an enterprise. In 1983 Ian Mitroff published Stakeholder and organizational mind. This subject and Stakeholder theory has not intersected Project Management Theory yet. Our thesis attempts to extend the theory of K. Artto (Artto et al., 2008) on autonomy and number of stakeholders to the stakeholder theory

Relevance of the research

This research is very crucial as human factors a becoming critical to project strategies. The research will try to bridge the gap between academic research and practice in industry. This research aims to develop a system dynamics method for complex projects to enable managers take timely decisions.

In complex projects, from a high level view point, the contract formation is done. Subsequently, a L1 level schedule is prepared. As the project progresses, various changes take place in the project and change management becomes a major aspect. With such changes, many uncertainties arise and conflicting interests of stakeholders come into play. In systems theory research, catastrophic theory and chaos theory such small events that catapult the large eventuality has been researched, but no such research in project management of complex projects has been done. Through a system dynamics approach a holistic framework can be made to capture such occurrence and thus guiding the project managers to take timely actions. This will also address the gap in literature to address such human factors.

In the age of AI where systems are gaining prevalence and how humans interact with them is critical, this research shall guide how human factors should impact this implementations of systems. The proportion of impact of human factors and of projects will be crucial to projects in the future world and this research will add to this body of knowledge. Further our research brings forth an integral view of project strategy for the first time thereby building on the theory of project management.

Objectives and Scope

The scope of research will be to elaborate various aspects , theories and models used in project management, strategy, risk and human factors. Through an extensive cross-functional literature survey the research gap will be studied and the critical parameters will be ascertained to be studied. The research will limit itself to the study of the human factors and human factors risks which are crucial for a project strategy.

Our research aims to contribute to the development of theory of project strategy and we shall conduct our research in the large scale complex projects sectors in India from core sectors like steel, cement, ports and infrastructure.

Industry segments : Coal Handling, Steel Plant, Cement, Power, ports and infrastructure

The Objectives of the research will be:

- To find the critical human factors in a complex project
- To ascertain the impact of these factors on project strategy for various scenarios like schedule crashing, claims settling and dispute resolution
- To develop a system dynamics model to observe the variables which impact project strategy.

Concepts/Theories/Philosophies

The various concepts and theories cover project management, complexity, economics, human resource studies, psychology, operations management, system dynamics, strategy, risk, leadership, Balance score card, anthropology, sociology working capital management, project valuation and ergonomics. All these theories are touching our research we will state them here and identify which have not being explored and which have been explored and used actively in our research.

Complexity: Chaos theory focuses on the study of dynamical systems where apparent random states of disorder and irregularities are secretly governed by underlying patterns and predictable laws which are highly sensitive to initial conditions. In 1960 Edward Lorenz, a professor in MIT discovered chaos which later was synonymous with the 'butterfly effect,' an extreme sensitivity to initial conditions and also lead to discovery of Lorentz attractors, a set of equations called Lorentz equations. A metaphor to explain it was flapping of a butterfly's wings over the Amazon influenced the weather in Bejing. This phenomenon led to the birth of deterministic chaos. In

our research we will focus on dynamic complexity which is caused by feedback. We will do this with a system dynamics model.

System Dynamics: System Dynamics tries to understand the nonlinear behaviour of complex systems dynamically. It uses causal loops, stocks, flows. System dynamics was coined by MIT Professor Jay Forrester.We briefly explain a system dynamics model. A system dynamics model uses stock and flow diagrams and causal loops.Casual loops (CLD): A causal loop diagram (CLD) is a visualization (fig1) of different variables in a system and their interrelation. It consists of a node & edge for eg in the diagram see profits & sales volume. Here, profit and sales volumes are nodes and the edge links them. The +ve sign indicates that increase in profit will lead to increase in sales.

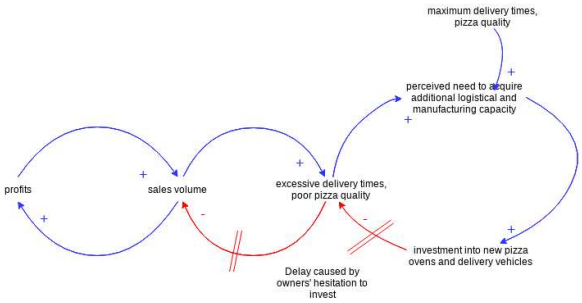


Figure 1: Source: https://warren2lynch.medium.com/system-thing-with-casual-loop-diagram-learn-by-examples-61dabdc4cdd

Stock and flow diagram: Stock variables are measured at a point in time. For example: the number of Covid-19 cases in Dec-2020. Number for errors made in inspections in Mar-2021. Flow variables are measured over a time interval. For example: Increase in competency of project team between Jan-2021 and May-2021 or Attrition of employees in FY 2020.

The power of the causal loop and stock and flow enable to capture the dynamic nature of human factors and thus their impact on project risk management. (Hussein et al., 2019) presents the following model.They explain how human rely on automated system for speed and accuracy (SAC) through this model. It shows nodes like Accuracy, human speed, tendency of verifications and flow variables like perceived recommended accuracy, trust accuracy etc. to conclude how the human trust plays a role in human reliance on automation.

General Unified theory of strategic performance and management (GUT) builds on generic principles of firm's performance based on accumulation and depletion of resources over time and it's interaction between rivals and other exogenous factors. The theory is proposed by Kim Warren of strategy dynamics. Our research does not do this for the firm but for project **Stacey Matrix** developed by Ralph Douglas Stacey helps to understand the factors constituting complexity. R D Stacey identified five areas: near agreement & near certainty, away from agreement but near

certainty, near agreement but away from certainty, zone of complexity, away from agreement & away from certainty. **Prospect theory** developed by Daniel Kahneman and Amos Tversky in 1979 postulates that individuals make decisions based on perceived gains rather than perceived losses assuming that losses and gains are valued differently by individuals.

Stakeholder Theory: Ronald K. Mitchell et.al proposed the salience model of stakeholders.

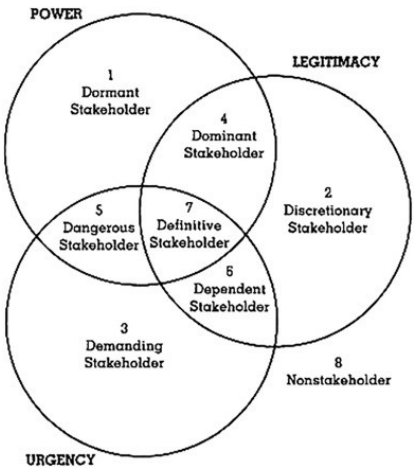


Figure 2: Source: Mitchell et.al

We shall develop this theory and modify this with introduction of competent stakeholders in our system dynamics model.

Human Factors: **Psychodynamic theory , Tripartite Theory of personality** proposed by Sigmund Freud, interaction between nature and nurture explains, personality as a combination of id, ego and super ego. **Eysenck's Personality Theory** explains personality based on biological factors. **Risk personality types** framework by Geoff Trickey explains 8 risk personality types. **Moore's Law** states that the number of transistors double each year though cost has halved. Hence, every couple of years we pay less for them. **Fuzzy Logic** coined by Lotfi Zadeh of University of Berkley as a method of reasoning which mimics the human reasoning. The approach of FL imitates humans thinking which involves all intermediate possibilities between digital binary values. **General Theory of Trust** authored by Christiano and Falcone explains the concept of trust, based on cognitive, institutional, cultural, normative and technical factors. **Trust Model** uses public key cryptography and collection of rules that informs the computer application to check legitimacy of a digital certificate. **Social Cognitive Trust** theory studies the influence, behavior and behavioral

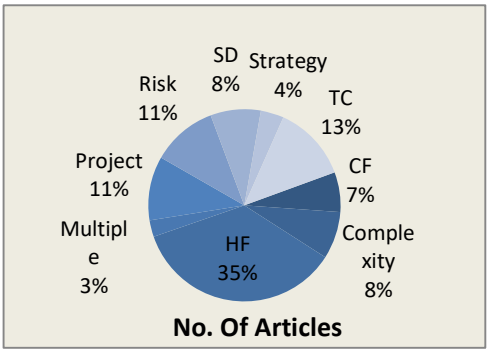
choices on three main factors: behavioral factors, environment and individual personality. **Agency theory** explains issues in the relationship between owners and their agents or managers in business. The conflict of interests between agents and owners is the well known principal-agent problem.

Project management

(Koskela Lauri, 2002) argues that there is a lack of theoretical development of project management. Through a review of literature they show that some authors have advocated that there is nothing to report on project management theory implying that either there is no theory or theory is not significant for the field. The author however argues that both views are wrong and a theory of project management is needed. The author goes on to base theoretical foundation from related theories of Transformation flow theory, Value generation theory, Management as planning , management as organizing, classical communication theory of language, thermostat model and scientific experimentation method. **Theory of production:** explains the principles based on which a business decides how it will use the inputs of raw material, labour, capital etc. to produce what mix of products it wishes to sell. Cobb-Douglas formulated the first production function in 1927. **Theory of Value:** is used in a diverse sense in philosophy. It is used with a broader meaning in moral philosophy, social and political philosophy, where it is deemed to cover some "evaluative" aspect. In a narrow sense, "value theory" is used for normative ethical and of concern to consequentialists primarily concerned with classifying things as good or bad. In economics this connotes **Intrinsic theory of value, Subjective theory of value. PMBoK:** Project Management Body of Knowledge is a guide on project management. We will be adding to this space greatly.

Trade Credit :**Stackelberg Game** has asymmetric roles of leader and follower. The "leader" moves first, and all the "followers" move after the leader. Named after Heinrich Freiherr von Stackelberg it evolved the first mover advantage in oligopoly market theory.**Nash equilibrium** is a theorem that states that a player can achieve the desired outcome by not deviating from their initial strategy. It is a concept from game theory where each player's strategy is optimal with respect to the decisions of other players. We shall reflect on these with our results.

The 4 areas of Projects, Risk, Human factors and Strategy are researched and we elaborate the research found in literature till date. A total of 263 articles, books, conference proceedings and thesis have been researched. This includes



- 22 books, book chapters, book series, book tutorials, book review, book proceedings.
- 7 conference proceedings
- 108 journal articles
- 4 thesis

The articles can be segregated into Strategy, Human Factors, Complexity, Project, Risk, System Dynamics, Cash flow and trade credit categories. Of these 163 are from these areas and the balance 100 are a cross-functional overlap between these domains. Thus giving a total of 389 works for all categories:

Literature Review:

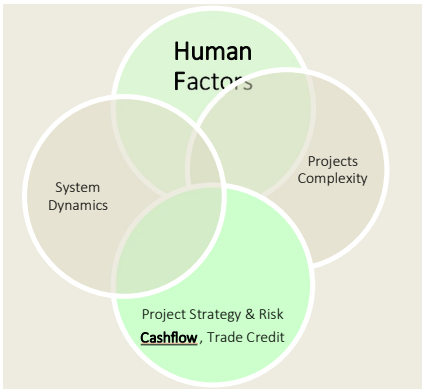
Area	No. of article
CashFlow	26
Complexity	31
Human Factors	139
Multiple	11
Project Management	42
Risk	43
System Dynamics	33
Strategy	15
Trade credit	50
	389

Cash flow related literature

(DeVaney et al., 1996) investigates cash flow and credit use 3 months post women's financial information workshops. The findings suggest association between participation in the program and change in behavior and attitudes.(Shash & Qarra, 2018) elaborate the cashflow management practices in Saudi Arabia for complex projects.(Khosrowshahi & Kaka, 2007) go beyond the traditional forecasting methods to drive the project with the cashflow projections.(Oral & CenkAkkaya, 2015)explains how CaR can be used in different scenarios to ascertain cashflow risk in projects.(Larkin, 2013) shows that intangibles like brand perception reduce cashflow volatility and riskiness of business.(Baranga & Ps, 2013) provides a cashflow strategy to reduce risk by reducing international trade. (Zaher, Heba; Illescas, n.d.) illustrates how cash conversion cycle can provide better cashflow and moderating credit.

Human Factor and Cash flow related literature

(Moro visconti, 2019) relates intangibles, economic value and cash flow.(Uzma et al., 2010)explains how DCF method aids valuation of intangibles. (Damodaran, 2007) gives a primer of valuation approaches. (Baldi & Trigeorgis, 2020)informs how human career valuation is carried out.(Baldi & Trigeorgis, 2020) presents a real options approach to value intangible investments. (Pantzalis & Park, 2009) investigate whether and how well firms' stock market valuations reflect their employees' collective skills and effectiveness relative to that of their industry peers and competitors and conclude that reliance on human capital intangibles may proxy for risk not fully accounted for by conventional asset pricing models, or alternatively, that the market cannot correctly price human capital intangibles for small size firms.(Monika et al., 2013)elaborates various valuation models for intangibles and their accounting.(Kutcher et al., 2008) illustrates the increase in productivity by strategic human capital use which in turn increases market valuation.(Tkachenko et al., 2018) elaborates on the DCF method to value intangibles.(Fulmer & Ployhart, 2013) provides a multidisciplinary review of existing literature that has been concerned with financial value associated with human capital resources. (Wilson & Stenson, 2008)concludes on attributes of information that give rise to its value as an asset.(Özer & Çam, 2016)illustrates how a firms can become competitive in long term by valuing human capital and relevant planning.(Roy & Shijin, 2018) models a 6 factor asset pricing with human capital factored in.(Ross, 1978)gives the basics of CAPM model.



Human Factor, Complexity and Cash flow related literature

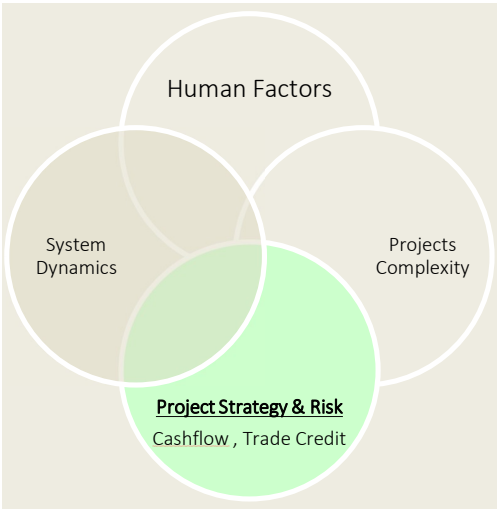
(Ferrer et al., 2020) studies intangibles and their risk on cashflows and how they contribute to complexity.(Iazzolino & Migliano, 2015) gives a framework to model intangibles into valuation.

Human Factor, System Dynamics and Cash flow related literature

(Kasiri & Sharda, 2013) provides a method to use system dynamics and real options to value intangible IT innovations. (Cui et al., 2010) shows a system dynamics application for cash flow management and strategy of trade credit.

Risk related literature

(Yuri, 2017)Introduces classes of fallacies inside standards of Project Risk Management (PRM) and practices to displace fallacies, gaps in PRM assessment. The author introduces 32 risk objects, best practices in PRM and ways to adopt correct methods, the psychological and organizational bias (Hidden Agenda - Principal -Agent Theory, "Anchoring" , Conscious and Unconscious bias) which can effect decisions by project managers in Risk Assessment. (Swin, 2017) Uses fuzzy logic to assess risk factors like: expert diversification, risk culture, process mining, human biases reasons, and personal factors (Hallowman, 2017) illustrates concept of system risks in complex projects, project specific and systemic risks and how to handle them. The human factors constituting these two types of systemic risks and state of team development including business leadership bias in estimates. Team development and IPA is critical and correlated to cost and schedule performance. Project Dicotomy of order and disorder is explained. (Corpoley, 2017) suggests shortcomings of prevalent risk management approaches and favors an Integrated schedule and cost risk management. (Agarwal, Monte Carlo Risk Analysis, 2017) introduces Monte Carlo simulations for risk management (Malik, 2017) elaborates how MCS can aid assessing contingency estimates.(Nasirzadeh et al., 2013)provides a fuzzy logic approach to risk management. (Agarwal, Integration of Project Risk Management into Enterprise Risk Management, 2017) argues to integrate PRM to ERM. (Plumery, 2017) provides speedy and forensic based project performance drawbacks and presents a risk centric approach. (Michale, 2017) a case study explaining complex decision making (Townley, 2017) illustrates various models to risk management.(Kreydieh, 1996) explains through a case study the financing risks in BOT projects.(Kahneman & Tversky, 2012)prospect theory introduces the outside view and how it can remove biases.

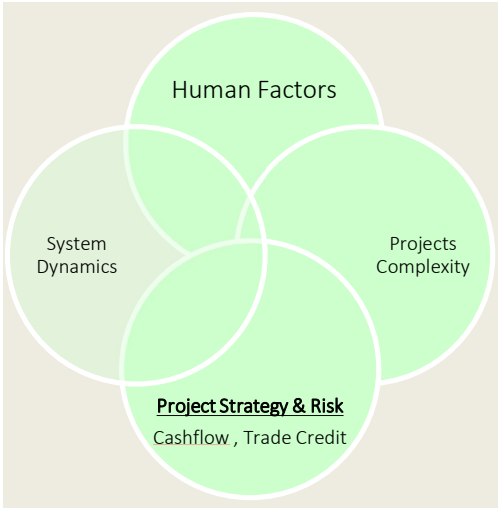


Project, strategy & Risk related literature

(Raydugin, 2017) provides a pre-bid stage risk assessment technique. (CIOCA, 2011) elaborates qualitative methods of risks management in an aviation project. (GALWAY, 2004) illustrates quantitative methods for project risk assessment. (MJ Thaheem, 2012) reviews quantitative techniques used in risk management in construction projects.(Awojobi, 2015) provides a cost and schedule risk planning for hydroelectric project.(Jarman & Dreher, 2018) illustrates Strategic Misalignment for divergent interests and suggests structured risk based solutions to handle them.(Nersesian, 2017) risk simulation for a solar project is illustrated.(De Meyer et al., 2002) describes management strategies to handle uncertainity.(Aven & Krohn, 2014) presents a new integrated perspective, to capture, understand, assess and manage the uncertainty in a practical operational setting. (Shenhar et al., 2007) proposes a project strategy framework.(Williams, 2016) show how success factors combine in complex interactions. By a case study method of a company working on two major construction programs the research describes factors contributing to project performance by mapping and analyzing paths from root causes to success criteria.(Artto et al., 2008) introduces four types of strategies for a project along the two factors of number of strong project stakeholder organizations & project's independence: , flexible mediator, strong leader, obedient servant, independent innovator. It contributes to development of new and context-specific project management bodies of knowledge in the future.

Project, Risk and complexity related literature

(Thamhain, 2013) suggests specific work environment to control complexity and risks.(Sumit Roy (ICFAIJharkhand), 2019) provides a framework for risk management including human factors and factors like pace of project, structural complexity, dynamics of project, Uncertainty of project, socio-political influence, and Critical risks. (Dale F. Cooper, 2005)deals with risk management in large complex projects. To managing risk better, project teams need to obtain better project outcomes.



Human Factor and Risk related literature

(Zwikael & Smyrk, 2015) that in turbulent environment ,trust of the project owner in the project manager is more effective , whereas in in a more stable project setting, more control by the project owner of the project management process is a superior management approach. Finally, management role of the project owner is discussed and a project governance model is introduced. (Organ & Stapleton, 2017)outlines a study to address human factors in systemic financial systems providing a view to relationship between human and tech, functionalist, interpretive, radical humanist and radical structuralist world view. (Kahneman 1934- author, n.d.; Kannengiesser & Gero, 2019) provide an explanation of the prospect theory and a framework to apply the same.(Kahneman & Lovallo, 1993) explains how human psychological bias from overconfidence errs decision making.(Flyvbjerg, 2006) highlights inaccuracy and forecast risk in Project managers, optimism bias and strategic misinterpretation.(Flyvbjerg, 2009) &(Flyvbjerg et al., 2009) illustrates how biases decisions and principal-agent theory plays in large infrastructure projects. An outside view de-biasing technique that has proven successful in overcoming both delusion and deception in private and public investment decisions is shown for illustrating the RCF method.(Flyvbjerg & Budzier, 2011) illustrates the risks in IT projects and the myths and dangers.

Human Factor and Risk and Complexity

(Nachbagauer & Schirl-Boeck, 2018) conclude that based on resilience research and Human Factors research, ideal types for managing the most unexpected events in projects. While humans are possible sources of error, they are at the same time the most valuable resource to manage the

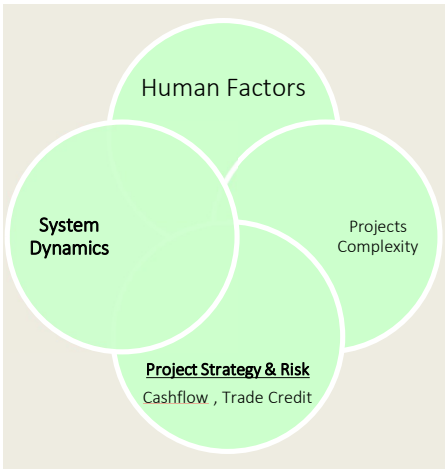
unexpected successfully.(Andreas G.M. Nachbagauer, 2018) develop a useful framework combining the social dimension comprises the project manager, the project team and the project-oriented organization and the time-related dimension.(Marshall & Ceylan, 2019) illustrate how to obtain risk intelligence.(Giezen, 2012) studies a metro project in Rotterdam and lessons on how to reduce complexity.

Human Factors, Project risk, Complexity and System Dynamics

(Boateng et al., 2012) describe STEEP risks with a system dynamics model and their interactions in megaproject development and concluded the inefficiency of prevalent methods to assess risk.

System Dynamics related literature

(Torres, 2019) provides a systematic literature review of 498 articles and find that 4 major areas are studies viz model validity, modeling of dynamical problems and understanding and improving decision making in system dynamics.(Tang & Vijay, 2001) provides a history of system dynamics and possible prospects in future.(Sisodia et al., 2016)provides a system dynamics model for solar power policy on countrywide level.(Ahmad et al., 2015) illustrates solar policy making by feed in tariff in Malaysia and scenarios till 2050.(Vafa-Arani et al., 2014) guides policy makers for reduction of air pollution by taking 2 sub-systems i.e. urban transportation and air polluting industries.(Yu & Wei, 2012) shows how genetic algorithm and system dynamics can be used jointly to assist policy making.(Ghaffarzadegan & Rahmandad, 2020) shows how uncertainty can be captured through system dynamics modeling by to understand the state of the COVID-19 pandemic. It shows that the state relies on infection and mortality data and how to the put-break rate. (Lyneis & Ford, 2007) review literature and past works on project management and system dynamics & synthesize the policy messages for project policy making the authors show that system dynamics can improve project management and develop a theory in project management which is lacking. (Tan et al., 2010) show how system dynamics better predicts cash flow.(Sterman, 1961) explains put the foundation of system dynamics in business. (Forrester, 1993) illustrates development in system



dynamics space.(Warren, 1999) provides the basics of system dynamics for business strategy. (Warren, 2018) provides a tutorial for analysts.

System Dynamics and Projects related literature

(Rodrigues & Bowers, 1996) compares system dynamics against traditional approaches of project management.(Huang, 2008)illustrates how project management teaching can be enhanced with system dynamics methodology through an experimental study. (Kasperek, 2016) shows how design and engineering can be improved through system dynamics. (Williams et al., 2003) show how to use system dynamics for litigation on claims for project management.

System Dynamics, Complexity, Risk, Strategy and Projects related literature

(Lyneis et al., 2001) shows how **system dynamics** can be used for developmental projects which bring in high risk and uncertainty through complex project in defence. (Chapman, 2017) shows how stocks and flows, the basics of system dynamics, can manage complexity and avoid gaps and omissions in project risk management.(Warren, 2005) gives a system dynamics perspective as a powerful logic that offers substantial improvements in dealing with issues in strategic management, both for one-off challenges & continuous enterprise strategy.(Raydugin, 2020) gives a detailed process of using non-linear dynamics, system dynamics and Monte Carlo simulations for complex projects.

System Dynamics and Human Factors related literature

(Caulfield & Maj, 2001) explain benefits of SD to prove the Fred Brook's Law to capture the complexity of human interactions.(Hussein et al., 2019) human trust model under speed and accuracy.

Research Gap

We find in the above studies that though project management success and critical factors have been studied, human factors specific research is very little. Our research has therefore tried to focus on these factors and their impact. We attempt to filter the factors from these studies and evaluate their impact on an area which is virgin. This is the area of “project strategy”.

Based on the synthesis of above literature review we have the following variables/constructs for human factors:

Table 1:Literature Survey Constructs

SN	Author	Description	Country	Sample Size	Approach/ Type of model
Errors due to humans					
1.	(Oropesa, 2020)	Human error and project success relation and causes of errors	Columbia	14 projects 2 companies	Rasmussen Model, correlational-explanatory
2	(Daniel W. M. Chan 1, 2022)	Main causes of human error	Iran	17 experts	Delphi method
3	(Rose, 2012)	Human factors and safety culture.	UK	300	Case study and survey
4	(EWEJE, 2010)	Human factors and project failure, decision making	France	107	Factor analysis
5	(Dekker, 2010)	Systems thinking v/s Newtonian ethic	Sweden	-	philosophical
6	(Ajith1, 2022)	A framework for Human error assessment	India		HEART method
7	(Samarth Ramprasad. K, 2019)	Human reliability in construction projects	India	1029	Survey
Communication					
1	(Turki Alsudiri, 2012)	Factors affecting misalignment between project management and business strategy	UK	4	Case study
2	(Digitemie², 2024)	Strategic project management framework	Nigeria		Review
3	(Rehan, 2024)	Project success factors	Australia	109	EFA, Regression
4	(Wawak, 2024)	Team management and project quality	Poland	510	Survey
5	(Haridharan*, 2017)	Success factors in projects in construction	India		Literature review SPSS
6	(Alias, 2014)	Critical Factors	Malaysia		Conceptual
7	(Prabhakar, 2008)	Project success	India		Review paper
Flexibility of Project Manager					
1	(Cheng M. I., 2005)	Qualities of a project manager	UK	60	Focus Group from 2 construction companies.2 Way ANOVA
2	(Sunindijo, 2015)	Skill components of project managers	Australia	107	Factor analysis
3	(Webb, 2014)	Project based International Joint Ventures to develop a framework	UK		Interview & Case study
4	(Shenhar, 2015)	A research based approach to project management	USA		Theoretical
Decisive Client					
1	(Neringa GUDIENĖ, 2014)	Critical Success Factors	Lithunia	27	Analytical Hierarchical process
2	(Johnson Matu*, 2021)	Clients support on contractor's performance	Kenya	62	Stratified sampling , Regression
3	(K.C. Iyer, 2004)	What factors impact cost performance	India	300	Factor Analysis
Trust between client and contractor					
1	(Astha, 2006)	Client-contractor relation DMRC metro project	India		Interview
2	(Pengpeng Xu, 2014)	Policy making and EPC for projects in buildings	China	8	Focus group, Analytical Network Process
3	(Weiping Jiang, 2017)	Trust and project success investigation	China	366	Exploratory Factor analysis, SEM

4	(Shahnawaz Khan, 2011)	Contracts and trust in projects	Pakistan		Literature Review
5	(Bakker, 2010)	Project success and trust from owner's perspective	Netherland		Q-methodology
6	(Manu, 2015)	Trust between contractor and sub-contractor	UK		Case study and interviews
Client's experience					
1	(Akintoye, 2002)	Conceptual framework with client's attributes	UK		Literature review
2	(Shakya, 2019)	Assessment of risk factors	Nepal		Literature review
3	(Altarawneh, 2018)	Critical success factors on critical delays	Abu Dhabi	323	PLS-SEM
4	(Shakir Iqbal, 2024)	Causes of project failure and cost overun	Pakistan	104	Questionnaire and interview
5	(Koushki, 2005)	Causes of delay in construction	Kuwait	450	Questionnaire survey and frequency analysis
Support of senior management					
1	(Iqbal, 2015)	Project success factors	Pakistan	125	PLS-SEM
2	(Ahmed R. H., 2021)	Senior management support on project performance	Pakistan	310	Correlation, Regression
3	(Thamhain, 2004)	Project environment and performance	Global	2240	Content Analysis, Kendall's Tau rank-order correlation
4	(Moza, 2024)	Critical success factors and project success	India	213	ANOVA
5	(Alias, 2014)	Critical Factors	Malaysia		Conceptual
Contract Handling by Project Manager					
1	(KEBEBE, 2022)	Factors influencing over run in projects	Ethiopia	70	Regression
2	(Shibani, 2015)	Project manager role in construction projects	India	20	Statistical
3	(Jha, 2013)	Determinants of project success	India	300	ANOVA
4	(Sanchaniya, 2024)	Framework for Project management in construction	India	78	Principal Component Analysis
Effective feedback					
1	(Schrapers, 2018)	An examinations of methods in construction project management	Scotland	9	Interview
2	(Pinto, 1988)	Critical Success factor for effective project management	US		Conceptual
3	(Albert P. C. Chan, 2001)	Design and Build project success factors;	-	53	Multivariate analysis
4	(Chan, 2004)	Factors affecting the success of a construction project.	-		Conceptual
5	(Alias, 2014)	Critical Factors	Malaysia		Conceptual
Reputation of project manager					
1	(Singh L. &., 2024)	Traits and skills of PM to complete projects	India		Literature review
2	(Oh, 1999)	Case study on project management	US		Case study
3	(Sankaran, 2020)	Project manager's influence on strategies	Australia		Case study
4	(Barnett, 2006)	Corporate reputation	Australia		Theoretical
5	(Olawale, 2020)	Key drivers of reputation	UK	134	Mixed method research
6	(Karlsen, 2020)	Project manager's role in public change project	Australia	-	Case study and interview
Charisma of Project Manager					
1	(Blaskovics, 2016)	Project manger's attitude and leadership style	Hungary		Conceptual
2	(Ahmed R. &., 2014)	Project Manager's leadership competencies to Project success	USA		Conceptual
3	(Zhao, 2021)	Impact of Transformational leadership on project success	China		Empirical, Meta analysis

4	(Shah, 2018)	Impact of charismatic leadership on Construction project performance	Nepal	154	Empirical, Factor Analysis
5	(Keegan, 2004)	Transformational leadership in project based environment	Netherlands	115	Empirical
Leadership of project manager					
1	(Prabhakar G. P., 2005)	Transformational leadership in projects	Global 28 countries	107	Empirical, Regression
2	(Chacko, 2023)	Critical Project success factors	Singapore	-	Empirical
3	(Rustam, 2024)	Dominant factors of Project manager competence in projects in Construction industry	India	-	Literature review
4	(Turki Alsudiri, 2012)	Aligning project management to business strategy	Saudi Arabia		Conceptual
Organized Project Team					
1	(Han, 2019)	Stakeholder Management for Project success	Vietnam	163	Empirical, Factor Analysis
2	(Sudhakar, 2016)	Project success	India		Literature survey
3	(V. Sanvido, 1992)	Critical success factor	USA		Empirical
Stress					
1	(Wang, 2020)	Workplace stress and project success	Pakistan	453	Empirical
2	(Sampaio, 2021)	Stress as a factor in emotional intelligence	Global	131	Confirmatory factor analysis
3	(Mei-yung Leung, 2011)	Performance of construction project managers		108	SEM
4	(Morris, 2010)	System dynamics model for stress			SD Model
Engagement by Project Manager					
1	(Saadé, 2015)	Factors of Project manager success	Canada	66	Exploratory Factor analysis
2	(Montenegro, 2021)	Project manager's emotional intelligence on Project success	Serbia	110	Confirmatory factor analysis and SEM
3	(Beringer, Jonas, & Kock, 2013)	Stakeholder behaviour and engagement intensity of project manager	Germany	426	Regression
4	(Prabhakar, 2008)	Project success	India		Review paper
Anchor Bias					
1	(Lorko M. , 2020)	Anchoring effect in project schedules	Australia	93	Regression
2	(Romanazzi, 2024)	Behavioural biases in Project evaluation and cost	Venice	-	Case Study, Regression
3	(Lorko M. S., 2021)	Improving Project Scedules	Australia	139	Experimental
4	(Flyvbjerg, 2009)	Human bias in projects	USA		Case Study
5	(Cadorin, 2015)	Portfolio selection and biases	Sweden	8	Expert Interview
6	(Shang, 2017)	Risk management	Global		Conceptual
Risk Personality					
1	(Murray-Webster, 2021)	Making Risky decision in projects	USA		Conceptual
2	(Hillson, 2019)	Capturing upside of risk in projects	USA		Conceptual
3	(Trickey, (2017))	Risk Personality	-		Conceptual
Self Awareness					
1	(Creasy, 2013)	Personality trait of project managers impacting project succes	USA		Conceptual
2	(Thomas, 2018)	Project manager's emotional intelligence and Project success	USA	104	Empirical, ANOVA
3	(Zhang, 2013)	Improving performance Emotional Intelligence	China	112	Empirical
Persuasiveness					
1	(Simango, 2022)	Critical success factors	South Africa	33	Empirical

2	(Turner, 2006)	Leadership style and type of project	USA		Conceptual
3	(Hauksson, 2015)	Persuasiveness as a trait of influence	Finland		Theoretical
4	(Rivard, 1999)	Project Manager's Influence tactics and authority	Canada	139	Confirmatory Factor Analysis
5	(Keane, 2022)	Social cognitive perspective	-		Theoretical
6	(Jansen, 2021)	Influence in project management	South Africa	99	Factor Analysis, Regression
Technical expertise of project manager					
1	(Rwelamila, 2010, September)	Technical expertise of project manager	South Africa	50	Reliability Analysis
2	(Ma, 2014, November)	Skills of construction project manager	Australia	57	Interview and descriptive statistics
3	(Gillard, 2009)	Soft and technical skills of project manager	USA		Theoretical
Assertive Project Manager					
1	(Solga, 2014)	Interpersonal skills of project manager in successful project management	Germany		Conceptual
2	(Gruden, 2018)	Behavioural competencies on	Slovenia	70	Multivariate Analysis
Aggressiveness of project manager					
1	(Martens, 2018)	Impact of entrepreneurial Orientation (Risk taking, aggressiveness, proactiveness, autonomy) on project success	Brazil	100	SEM
2	(Ullah, 2020)	Impact of Entrepreneurial Orientation on Project Success: Mediating Role of Technological Orientation and Moderating Role of Top Management Support.	Pakistan	258	SEM
Adaptability of Project Manager1					
1	(Gewanlal, 2015)	Project Manager Attributes for project success	South Africa	163	Descriptive statistics
2	(Cheng M. I., 2005)	Project manager's skills	UK		ANOVA, Principal Factor extraction

We shall establish how strategy and risk are closely associated, in fact we may say inseparable and base our study in this research gap. In other words, we are for the first time studying the impact of human factors on project strategy. We can claim that because an attempt to define of project strategy with human factors has been done only in a few works of Artto. We bring forth for the first time the integration of the concept of strategy in business by Rumelt and that of Mintzberg with that of Artto. We take this further by putting it in the stakeholder theory model conceptualization. The novelty of this research lies in the fact is that it's not just a patchwork of 3 theories put together but a holistic attempt to bring forth the impact of human factors on this integrated understanding of project strategy through a system dynamics model. Thereby paving the way for a theory of project management.

The research not only reduces the vacuum in human factors in project management is also our research bring for a definition of what human factors mean in respect of project strategy. Our research methodology section shall elaborate more on this. However, since we are discussing the

research gap, it is pertinent to mention that the factors are chosen from existing literature and categorized in buckets to add to the body of knowledge of project management.

Hypothesis

$H_0$1: Human Factors have no significant impact on project strategy

$H_0$2: While crashing the project schedule human factor risk has no significant impact
$H_0$3: Contract Handling has no significant impact on project strategy
$H_0$4: Human factors have no significance in ploy and direction in complex projects
$H_0$5: Project Manager's qualities has no influence on project strategy.
$H_0$6: Project Manager's qualities has no influence on ploy and direction
$H_0$7: Trust between contractor and client has no impact on project strategy.
$H_0$9: Team traits have no significant influence on project strategy
$H_0$10: Client traits have no influence on project strategy
$H_0$11: Error due to human no significant level of influence on project strategy

Based on the results of the hypothesis we test the various scenarios of project strategy and risk.

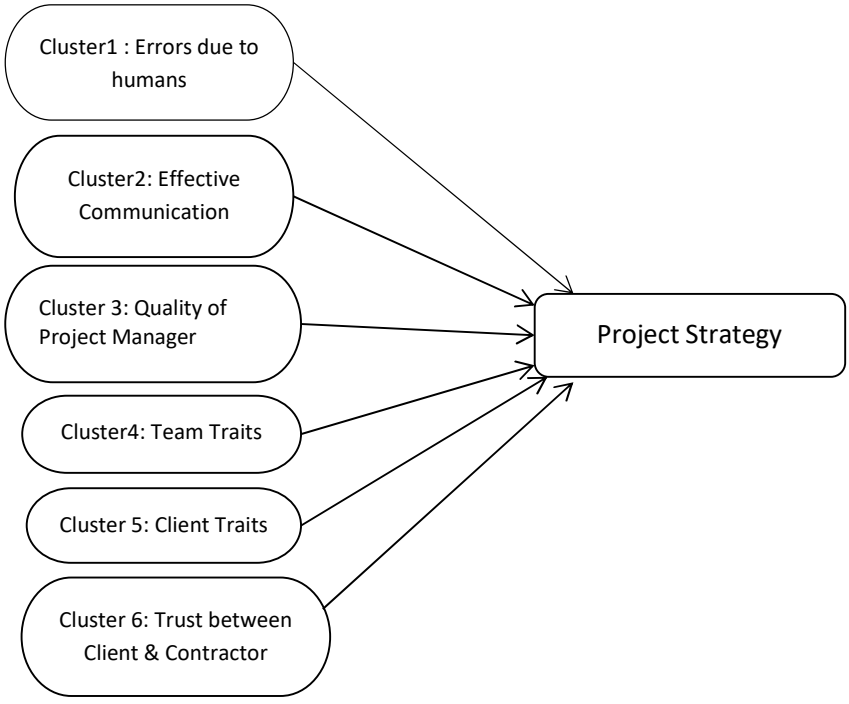


Figure 3: Conceptual Model

Research Design & Methodology

Human factor variables are constructs used in the research. Though literature survey of 6 large databases we filtered 23 variables to study the impact of Human factors on strategy and risk in complex projects.

In the research design stage we deep dive into the approach of how relevant information to answer the research questions shall be obtained.

As mentioned in the methodology while literature survey identifies the gap, we nor move deeper into how to fill this gap. We have already put our hypotheses and to validate these we need to now find the right research method. The first stage of this is to design a well structured questionnaire (for project managers and team members) and semi structured interviews with experts in this field (project managers with more than 30+ years of experience in participating organizations).

The second stage is that of the system dynamics modelling. In this stage we develop the model to see the impact of the human factors found relevant by our 1st stage research on the various project parts i.e schedule, cost and quality. In past studies, the impact of employee attritions, trade credit, rework etc. has been studied separately, the system dynamics model incorporates all these factors. In fact through the model we shall attempt to capture the dynamic complexity and their impact on project cashflow.

It is relevant to state here that our approach in the 1st and 2nd stage are connected but disparate. In the first stage project strategy is the dependent criteria while in the second stage it is broken into tactics and factors and we study the impact on project cashflows to study the impact of these factors. The combined provide a holistic view of strategic and tactical parts and how they intermingle.

The third stage is where we develop the system dynamics model of stakeholder impact on project strategy. This brings out the complete picture of the 1st and 2nd views of project strategy and provides the holistic view.

The questionnaire was designed as a multidimensional prism. It has been categorized into :

1. Human Factors V/s System Factors,
2. Project Strategy from the stakeholder point of view of project autonomy into
3. Risk Attitude

The data collected in the pilot survey was analysed through R software and the descriptive statistics was derived.

In this questionnaire survey data is collected from 129 participants. The participants are chosen from project based companies. Majorly from energy and construction related projects which have large complex projects.

Sample size : A total number of 615 participants participated in the survey

Results from survey

Survey Response

Full responses were 242 and later another 6 responded i.e a total of 248. Of the incomplete 373, 21 more could be extracted so a total of 263 responses could be analyzed.

Data Analysis:

Statistical R and excel for data analysis and Vensim PLE for system dynamics model have been used.

Findings:

Of the Human factors 6 clusters viz. Errors due to Humans, Effective communication, Project manager quality, Project Team, Client and Trust is made. Of System Factors 4 clusters viz. Task, System, Transactional and Business clusters are made.The question, total 29 nos. are divided into the following categories and the data shows their inclination to which factor:

Table 2: Human Factor V/s System Category wise

	Human Factors Score	**System Factor Score**
Project Strategy	**14.08**	10.53
Project Success	**11.69**	5.72
Risk	13.5	**22.3**

Value	5.36	**9.58**
Project Crashing	1.3	**3.7**
Procurement	27.25	**31.6**
Project Condition	8.64	**9.15**
Customer Satisfaction	**12.18**	6.27
Situational / Project Tactic		
Distress	**7.3**	2.86
Dispute	**9.28**	5.17

System Factors considered were majorly processes, inputs and outputs of a project viz: Systems and Processes, Insurance, Scope Clarity, Contracts, Feedback, margins, ROI, Planning and scheduling, Resources, Organized team, Responsibility distribution, Alignment, Budgets and controls, System mapping, Cashflow, System design, Scenario planning, Payment terms, Size of supplier, competition, time for negotiations, Commercials, process of negotiation. Price.

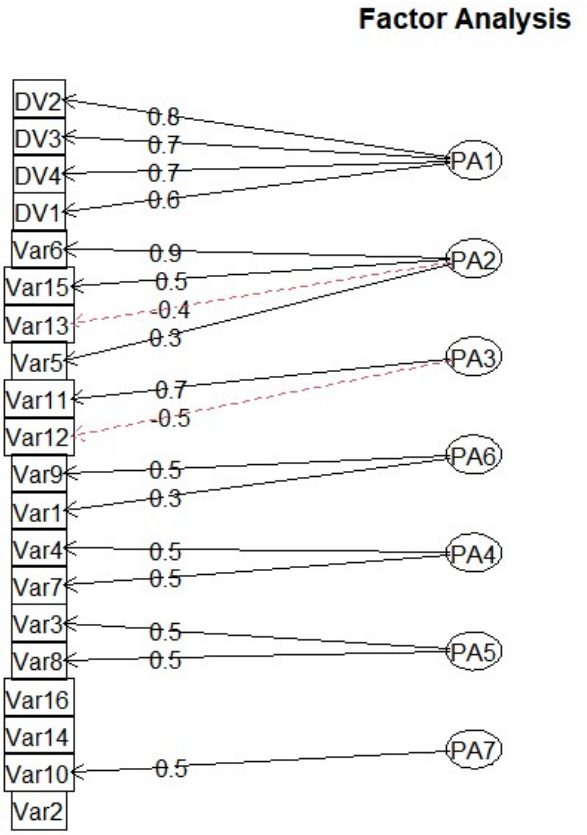
From the above we observe that System factors were given more importance for Risk, Value, Schedule crashing, Procurement and Project Condition, i.e. for task oriented, commercial or conditions, the human factors were perceived less important.

When considering Strategy, Customer Satisfaction, and situational questions of distress and dispute, human factors were given more importance.

Hence, we may say that on a tactical level for subjective areas like Project strategy as a whole, customer satisfaction and relation based situations, human factors were given more importance. While for monetary, commercial and procurement issues, system factors were given more importance.

Exploratory data analysis:

Once we have completed the data analysis of the received data and derived a sense of the respondent's views from the obtained data we move to conduct our EFA in R.



The above are the 7 factors

The above has PA1 as dependent variable as Project strategy.

PA2 has Var 6, Var 15, Var 5 and Var 13 i.e charisma of project manager, reputation of project manager, leadership of project manager and negative relation with effective feedback by project team, i.e. Effective feedback has a negative correlation with project strategy. We can call this factor Strong Leader.

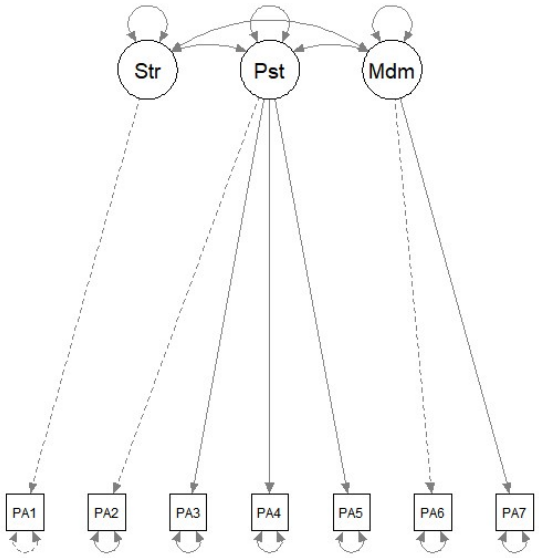
PA3 has support of senior management and contract handling by project manager, which again has a negative relation. This is an obedient servant factor.

PA4 has flexibility of project manager and organized project team as components we can call this Flexible moderator.

PA5 has Engagement by project manager with team and client and Decisive Client. We can call this as Innovative Leadership.

PA6 is Trust between client and contractor and errors due to humans. This is the Trust factor.

PA7 is Client's experience in the project. Though no weights are given, risk personality, anchor bias and effective communication has been put under this factor. This is the communication factor.



Confirmatory Factor Analysis

System Dynamics Model

Once the Human factor are identified we move forward to analyze the behavior in a system dynamics model.

However, the model is developed in 3 steps. Firstly, we observe the impact of human factors in a system dynamics model with the cashflow. Secondly, we develop the Project strategy model of stakeholder view. Finally, we integrate all these model into one system dynamics model and observe the results.

The integrated model is shown below:

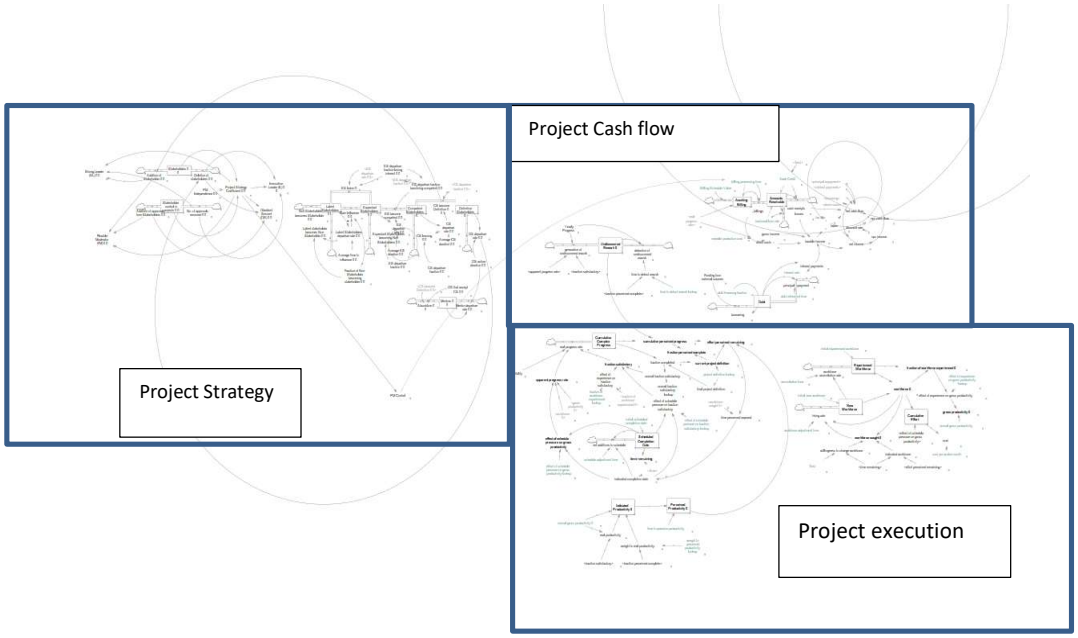


Figure 4: System Dynamics Model

The above shows the Net Income and Cashflow, which is -ve and decreasing overtime with the base setting at 0.9 PM Independence.

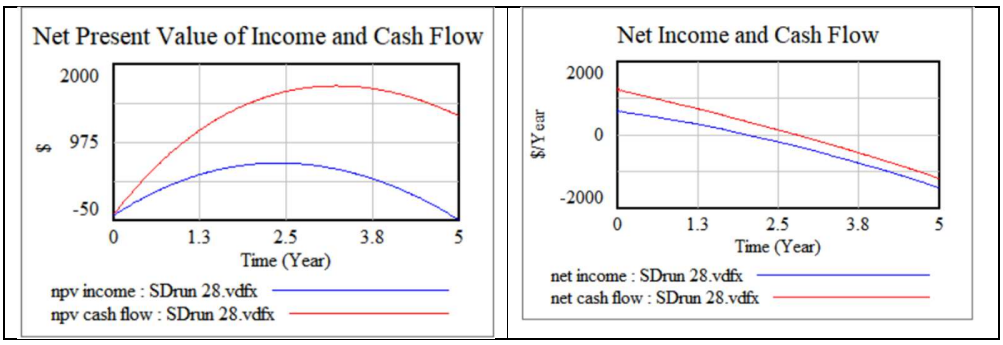


Figure 5: NPV and cashflow results

With change in PM Independence to 1.388 the following results. A positive NPV of Income and Cashflow but negative net flow indicating gap funding requirement.

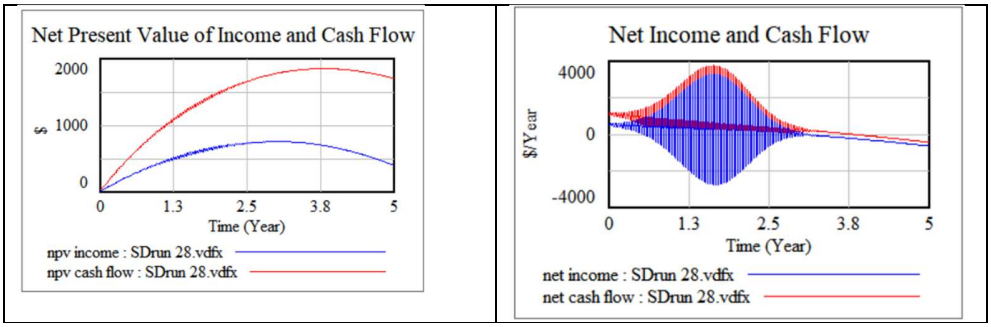


Figure 6: NPV and Cashflow scenario 2

At PM Independence1.425, we get an amplified flow and gap funding.

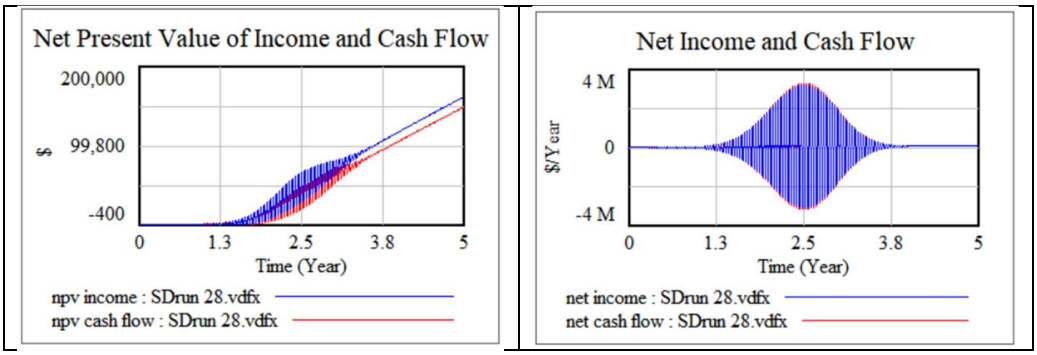


Figure 7: NPV and Cashflow scenario 3

However, net income and cashflow variation starts after 2.3 years.

With the same PM Independence and increasing Schedule Crashing from 1 to 3.35 we get a funding requirement of $10Mil instead of $3.5 Mil. Also this could mean a surplus of $10 Mil and $3.5 Mil due to faster completion.

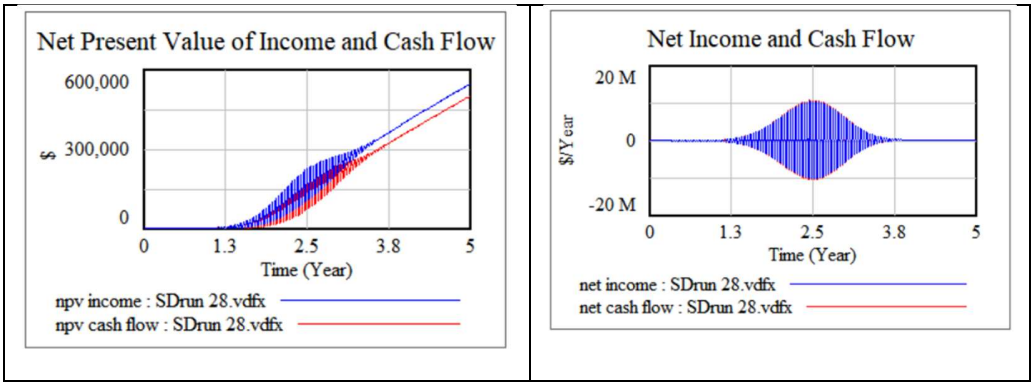


Figure 8: NPV and Cashflow scenario 4

With the change in competent stakeholder average duration from 15 to 22, we get $40,000 funding and lower net cashflow. Which is reduction of risk in the project.

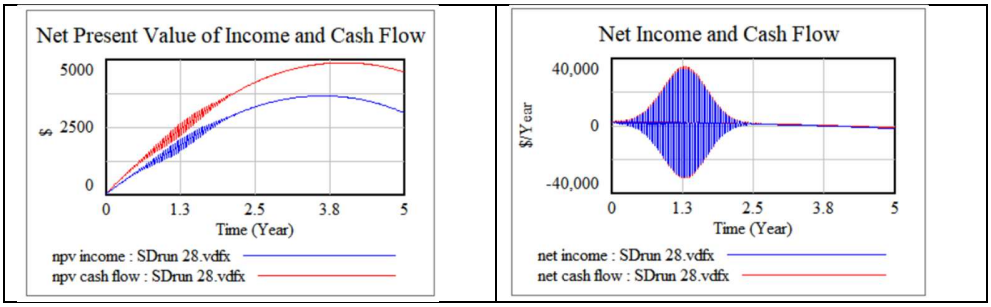


Figure 9: NPV and cashflow Scenario 4

Challenges / difficulties

1) Which statistical methods to apply and to find the critical variables?
2) Identify and convince experts from the field of project management, human factors and system dynamics for interview
3) Educate the project management experts about system dynamics.
4) Time to balance work and research
5) Change of guide

Conclusion and Discussion.

Our first research objective was to evolve an integral definition of project strategy, which we have crystallized to a great extant with our results and then the system dynamics approach. Risk has been an integrated feature and not separately dealt with as we set out by saying strategy and risk are coupled, one without the other is like discussing only about risk. When we state strategy, risk is implied. Many previous works have defined risk into political, strategic etc. However, we see risk in our research from the point of view of strategy.

The second objective was to find the degree of impact or extant of influence of human factor over system factor. In results section we found that human factor have significant impact, but the perspective is very important. If seen from a different lens system factors shall appear more significant!

We also provide a personality and environment matrix to map strategies as per project system.Our research has contributions for practitioners, academicians and industry.

Time frame for the reserach completion of the major milestones (start date, and end date)

	Tasks to be achieved	Start date	End date	1	2	3	4	5	6	7	8	9	10	11	12
				Quarters											

Determine definitive research question	Formulate research plan and get approval from supervisor & find Research Gap	Feb-2021	April-2022	
Define research model	Review literature, Identify experts, Develop design, Develop model	Feb-2021	June-2022	
Define methodology	Prepare Questionnaire, interview questions	June-2022	Sep-2022	
Prepare and write literature review	Internet, library	June-2021	April-2022	
Collect data	Send questionnaires, collect past data	June-2021	Mar-2023	
Analyze Data	Apply PCA technique & System Dynamics Model	Jan-2022	May-2024	
Write final work	Prepare draft thesis, organize, Correct & submit	Sep-2023	Aug-2024	
Submit final work			Sep-2024	
Review and defend			Dec-2024	

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Conference Presentations/Seminar

SN	Name of the Author/ Co-Author/s)	Topic	Conference/Seminar	Month/ Year	Country
1	Sarojkant Singh	Human Factors and Market Based Assets impacting Value Based Management – A System dynamics approach.	Ongale University conference proceedings - Value Based Management- A global perspective	2021	India
2	Sarojkant Singh	Complexity Handling with System Dynamics and effect of human factors on value creation- Case study of a diversified company.	System Dynamics Conference. Chicago.	2021	USA
3	Sarojkant Singh, C. Goubert, N. Bharti	Climate Change and Risk Management Using a Framework of System Dynamics, Big Data Architecture and Data Analytics	CAFEO 39	2021	Malaysia
4	Sarojkant Singh, R Ghosh, C. Goubert	CSR and trade credit for optimumcost of funds towerds a sustainable business model	Sustainable Development	2021	India
5	Sarojkant Singh, R Ghosh	FPO- turning challenge into opportunity	Creating a sustainable roadmap for FPOs in India	2021	India
6	Sarojkant Singh	Reflections on Agility and Agile Methodology from the ancient Yoga Sutras of Patanjali - Agile Epistemologies	IMI Bhubaneswar Doctoral Conference	2022	India
7	Sarojkant Singh	Ferro Alloy and green steel	Steel Tech Conference	2023	India
8	Sarojkant Singh	Dam safety	IIT Guwahati	2024	India
9	Sarojkant Singh	Digital Twin for mitigating cross border project risks of terrorism, cyber risk and asset damage	International Conference on Security, AI and Environmental Sustainability	2024	India

Conference Proceedings

Title of the paper	Title of the proceedings of the conference	Name of the conference	National / International	Year of publication
Human Factors and Market Based Assets impacting Value Based Management – A System dynamics approach.	Ongale University conference proceedings	Value Based Management- A global perspective	International	2021