Managing project intangible risk: socio-technical implications in a "projectified" world

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Abstract

Purpose – According to the Project Management Institute, 70% of projects fail globally. The causes of project failure in many instances can be identified as non-technical or behavioral in nature arising from interactions between participants. These intangible risks can emerge in any project setting but especially in project settings having diversity of cultures, customs, beliefs and traditions of various companies or countries. This paper provides an objective framework to address these intangible risks.

Study design/methodology/approach – This paper presents a structured approach to identify, assess and manage intangible risks to enhance a project team's ability to meet its objectives. The authors propose a user-friendly framework, Intangible Risk Assessment Methodology for Projects (IRAMP), to address these risks and the factors that cause them. Meta-network (e.g., a network of networks) simulation and established social network analysis (SNA) measures provide a quantitative assessment and ranking of causal events and their influence on the intangible behavior centric risks.

Findings – The proposed IRAMP and meta-network approach were utilized to examine the project delivery process of an international energy firm. Data were gathered using structured interviews, surveys and project team workshops. The use of the IRAMP to highlight intangible risk areas underpinned by the SNA measures led to changes in the company's organizational structure to enhance project delivery effectiveness.

Originality/value – This work extends the existing project risk management literature by providing a novel objective approach to identify and quantify behavior centric intangible risks and the conditions that cause them to emerge.

Keywords Intangible risk assessment, Meta-network analysis, Project complex systems, Socio-technical systems, Social network analysis

Paper type Research paper

1. Introduction

Governments and private-sector companies worldwide are faced with the need to deliver an increasing number of projects to accomplish their strategic objectives. Projects by their nature are complex social-technical systems occurring in dynamic multi-stakeholder environments (Cox, 2021). While project management principles continue to be used in the delivery of traditional projects like construction and information technology, they are also being applied in the areas of new-product development and corporate reengineering initiatives (Olsson, 2008; Pellegrinelli, 1997). This expanded use of project management tools has led to the emergence of the term "projectification" (Aubry and Lenfle, 2012; National

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Research Council, 2003; Sanchez *et al.*, 2009; William and Rūta, 2017). Projects are developed and delivered in the context of corporate cultures by teams of stakeholders (whose members may also come from various cultural backgrounds) where organizational barriers, biases and internal controls can adversely impact the behavioral aspects of teamwork (e.g. trust, cooperation, etc.). When this occurs, dysfunctional behaviors can arise within these teams (Atkinson *et al.*, 2006; Lencioni, 2002) putting the delivery of project objectives at risk. Teller and Kock asserted a need for standard approaches such as tools, policies, procedures and processes to avoid harmful behaviors and enhance cooperation (Teller and Kock, 2013). This highlights the need for project risk management to adopt a more holistic approach to address intangible risks associated with stakeholder behaviors, motivations and culture. (Hofman *et al.*, 2017; Olsson, 2008; Pellegrinelli, 1997). In this work, intangible risk is defined as: "a nonphysical event or condition, precipitated by antecedent conditions that are unique to the firm's administrative and organizational constructs, stakeholder composition, or culture, that can have a positive or negative effect on project objectives should it occur."

Empirical evidence regarding the more behavior-centric intangible risks is sparse in the existing literature and what exists tends to be general, with minimal focus on behaviors and the causal factors that influence them. When intangible risks are discussed frameworks to systematically identify and provide a level of measure are not attendant. For example, Jonas highlights behaviors such as teams blocking each other or displaying opportunistic behavior regarding resources but there is no empirical evidence provided (Jonas *et al.*, 2013). Others have identified the lack of role clarity, stakeholder involvement, coordination between project activities, conflicting project objectives, lack of cross-functional teamwork and interpersonal conflicts as having adverse effects on project delivery (Beringer *et al.*, 2013; De Reyck *et al.*, 2015; Hofman *et al.*, 2017) but without frameworks or objective measures. Although behavioral conditions have been identified generally (interpersonal conflict) and causal events specifically (conflicting project objectives), there is no information regarding how they might emerge and interact or how to analyze them. In their paper "A Multiple-Objective Decision Model for the Evaluation of Advanced Manufacturing Systems Technologies," Johann Demmel and Ronald Askin asserted that the traditional approach to investment decision-making using quantitative financial metrics is an "oversimplification." They went on to propose a multi-objective decision model that factors intangible benefits into the decision-making process. This approach allowed them to account for manufacturing intangibles such as "greater flexibility, shorter lead time, and increased knowledge in the use of new technologies" (Demmel, 1992).

To address this gap the following questions are proposed:

(1) In what ways can the development of a framework assist project teams to effectively identify and assess intangible risks and their causal factors during each stage in the project development cycle?

(2) How effectively can SNA measures be used to effectively characterize intangible risks to enhance project risk management?

(3) How effective is the assessment of intangible risk factors in a project environment that has high cultural diversity?

This work contributes to the field of risk management in several significant ways. First, it introduces IRAMP as a new empirically based framework for the identification of intangible project risk throughout the development cycle. Second, it pioneers the inclusion of intangible risks and the conditions that cause them in a meta-network construct, creating the ability to use dynamic network simulation models. Network analysis measures are identified for use in quantifying the implications of events and their influence on intangible risks. These quantitative measures identify relationships within the meta-network and the implications of making modifications. The ability to measure subjective factors will allow managers to enhance the overall effectiveness of the risk management process.

In the next section a review of the literature is presented, followed by a description of the methodology used in section three. Section four details the development of the IRAMP and section five describes the evolution of the meta-network and SNA measures. Section six presents a case study of the application of the IRAMP and meta-network in a corporate project setting comprised of multiple cultures and ethnicities. In sections seven and eight we discuss the findings and conclusions from this work.

2. Literature review

Risk has been a topic of research since the end of Second World War, with the first academic books published in the 1960s (Dionne, 2013). In response to the need for ensuring that projects were meeting schedule requirements, two methods emerged somewhat simultaneously in the late 1950s: the program evaluation and review technique (PERT) and the critical path method (CPM). PERT and CPM have similar formats: PERT charts were created for the United States Navy Polaris missile, while CPM was developed by DuPont to analyze the implications of trading cost for accelerating a schedule (Archibald, 2017; Engwall, 2012). Both are based on decomposition of the project into activities and utilize a linear flow-and-sequence format. PERT and CPM identify the activities vital to meeting objectives, providing a basis for identification and management of risk. Current risk management assessment methods are oriented toward systems that are linear and vary from basic qualitative assessment to complex statistical analysis primarily focused on tangible project factors. Risk profiles vary as a project moves through the development cycle and include a systemic dimension for portfolios of projects. However, the implications of human behavior on project objectives are highly variable and can be "blind spots" for individuals and teams (Dargin, 2013).

Project development can take many years to move from conceptual planning to initial operation, subjecting them to a myriad of dynamics. Empirically 60%–80% of projects fail to be completed on time and within budget (Deloitte Center for Energy Solutions, 2015; Morris, 2008), and these failures are due in part to human behaviors (Flyvbjerg *et al.*, 2009). For instance, fewer than 25% of oil and gas projects undertaken in the North Sea between 2011 and 2016 were completed on time and within budget. The Oil and Gas Authority (OGA) of the United Kingdom has attributed this low level of performance to events that are "non-technical in nature" (OGA, 2017). In a Global Oil and Gas Intelligence interview with Edward W. Merrow, founder and chief executive officer (CEO) of Independent Project Analysis (an industry-leading benchmarking consultancy), Merrow made the following observation regarding the cost and schedule performance of oil and gas megaprojects (those costing more than $1 billion): "Almost four-fifths of the projects, over three-quarters of the projects, have to be classified as failures. It's very disappointing, and this is counting projects over the last decade" (Haidar, 2014). Flyvberg *et al.* (2009) found that many project failures are caused in part by human behaviors. Trust is identified as being one of the most significant impact factors for project management in the intercultural context (Lückmann and Färber, 2016).

Major accident assessment is another area of study where the complexity of socio-technical systems exists. O'Hare proposed the "wheel of misfortune" to conceptualize the interactions among human agents, tasks, policies, local actions, procedures and philosophies specific to aviation accident investigation (O'Hare, 2000). In the arena of industrial plant operational safety, Rasmussen conceptualized the interaction between man and machine as a dynamic model of safety and system performance. His framework is a troika of constraints (economic, workload and performance), with operating points being influenced by subjective preferences exhibiting Brownian ("idiosyncratic and unpredictable") movements within a space of possibilities (Rasmussen, 1997). Projects face a similar dynamic to Rasmussen's safety and system model. In Rasmussen's model multiple networks (gradient toward efficiency, gradient toward least effort, counter-gradient for safety culture) exist within the overall delivery network. Both O'Hare's and Rasmussen's models of complex dynamic networks are conceptual and do not provide a means to quantify the forces working within the boundaries. Carley, on the other hand, proposed an analytical approach to assessing multiple interacting networks using the meta-network construct and dynamic network analysis techniques (Carley, 2002).

Frameworks such as work breakdown and risk breakdown structures (RBSs) are used as a structured approach for identifying and grouping project information. They can be used as checklists in project workshops, team meetings, etc. and can provide a common platform for organizations to capture issues, opportunities and can serve as a format for consistent in reporting. This paper proposes the framework, intangible risk assessment methodology for projects (IRAMP), is constructed utilizing an intangible risk breakdown structure (IRBS), risk inducement matrix (RIM) and meta-network conceptualizing projects as complex socio-technical systems incorporating behavioral response to events (Carley *et al.*, 2007).

Risk management in the context of organizational behavior is elusive given the primary focus of traditional approaches on quantitative methods and tools. Human behavior cannot be quantified in terms of probability and impact because of its adherence to mental models, beliefs and values, leaving risk estimation subjective and unreliable (Barber, 2005). The lack of research around human behavior risk in the project context is attributed to a general reluctance to discuss sensitive, subjective issues due to concerns of being seen as insensitive or provocative, making these issues difficult to address and resolve (Barber, 2005). It follows that an unidentified risk means no direct management of the threat. Studies tend to address an individual behavior but lack any empirical basis and none exist in the project context (Beringer *et al.*, 2013).

3. Methodology

This research develops and presents a seven-step process to classify intangible risk and identify causal events. The steps are as follows:

Step 1: Information gathering

Semi-structured interviews from a vertical sampling of the organization are used to gather perspectives of the reasons performance gaps exist. The information is consolidated and key themes are presented to management.

Step 2: Subject-matter expert workshop

Subject-matter expert (SME) focal points are identified from stakeholder organizations to support the process. The IRBS, risk causal factor lists (from literature and interviews) and meta-network details (Tables 5 and 6) are reviewed with the SMEs for completeness and endorsement.

Step 3: Information verification

A survey is developed utilizing the Level 1 risks in the IRBS to develop diagnostic questions. An ordinal scale is used and responses range from "strongly agree" (5) to "strongly disagree" (1). Participants are selected from all levels of each stakeholder organization involved in the project life cycle. The responsibility matrices from projects, as well as feedback from management and the SME focal points, are the basis for the survey participant selection.

Step 4: Survey analysis and validation

The survey responses are translated into a heat map to establish the areas for more focused assessment. The Level 2 risks are used to populate the RIM (Table 5), along with the consolidated list of risk causal factors from Step 1. A validation session is held with SMEs to (1) review the survey results and the RIM to gain alignment, (2) develop a list of project stakeholder teams from recently completed and ongoing projects to participate in workshops and (3) present results and recommended workshops to management for support.

Step 5: Project team workshops and data consolidation

Workshops for selected projects are scheduled (ca. 8 h) and require that representatives attend from all stakeholder groups. The first portion of the workshop populates the IRAMP templates (RIM using the IRBS and causal factors). Next, the individual networks within the meta-network are reviewed and completed. The final session in the workshop is to identify potential mitigations to the risk causal factors.

Step 6: Initial assessment and recommendations

Intangible risk and risk causal factor information gathered from the project team workshops is cataloged as either project specific by stage. The risk causal factors are then classified as either requiring management intervention or clarification. The recommended mitigations from the project team workshops are aligned with the appropriate risk causal factors. This information is then presented to management for their information and further deliberation.

Step 7: Decision support analysis

The meta-network for each project is simulated using commercially available dynamic network analysis software (ORA-PRO by Netanomics). Scenarios are developed to explore the project team–recommended mitigations to (1) identify key people (e.g. position in the network, workload, influence on risk causal factors, ability to influence network, etc.), (2) identify the influential risk causal factors and intangible risks, (3) identify tasks potentially most impacted by intangible risks and (4) draw insights into the network information flow. The methods used to gather the information necessary to develop the components of the IRAMP and the Meta-network are shown in Table 1.

4. IRAMP framework development

Frameworks are used as a structured approach for identifying and grouping individual project risks. They can be used as checklists in project risk workshops, for interviews, to capture lessons learned and can serve as a format for ensuring consistency in risk reporting. The general frameworks shown in Table 2 have been used in project risk management (Hillson, 2014).

Focus area	Method
IRAMP component	
- IRBS	Semi-structured interviews, survey and workshop
- Causal factor checklist	Literature review and workshop
- RIM	Workshop
Meta-network development	Conceptualization and literature review
Address study questions, IRAMP framework and Meta-network development	Workshops
Validation	Case study and analysis

Source(s): Authors' own work

Table 1. Methods summary

In these frameworks, there are several social or sociocultural categories, but none provides prompts to assess intangible factors (e.g. implications of outsourcing on team motivation). The ability to proactively address intangible factors like respect, trust and openness in a systematic way early in the project cycle is necessary for robust risk management (Uher and Toakley, 1999). Extending the concept of the risk RBS to include intangible risk requires the development of a framework identifying behavioral categories capable of materially impacting the overall effectiveness of project stakeholder interactions. According to Bordage, robust conceptual frameworks should be based on "sets of concepts, or evidence-based best practices derived from outcome and effectiveness studies" (Bordage, 2009). The behavior-centric elements (intangible risks) in Lencioni's book "The Five Dysfunctions of a Team" can be considered as a rubric in light of this qualification. Table 3 translates the five dysfunctions of a team into the IRBS in a typical RBS format.

Identification of and methods for proactive response to early warning signs can be found in publications and websites across various business sectors; however, they have rarely been discussed in project management literature (Haji-Kazemi *et al.*, 2013, 2015). Early warning as a concept is generic and can be applied to almost any set of circumstances where a need exists to have insight as early as possible regarding future occurrences. Like risk, early warning signs usually carry a negative connotation and an organization's culture or an individual's bias may impact the ability to recognize these important signals (Nikander and Eloranta, 2001; Haji-Kazemi *et al.*, 2015).

Causal factors like early warning signs can provide the project team with an indication of potential intangible risk responses. Causal factors are occurrences that affect human behavior and initiate a sequence of mental and emotional reactions as people attempt to make sense of unplanned changes or issues that arise in their working environment (Isabella, 1992). In the project context, politics (Haji-Kazemi *et al.*, 2015), misaligned project objectives (Beringer *et al.*, 2013), unclear or overlapping role requirements (Williams and Klakegg, 2012) and conflicting interpretations of policies and procedures (Thamhaim and Wilewon, 1975) are examples of causal factors. These can lead to interpersonal friction or "wicked messes" (Roth and Senge, 1996), with the potential to result in a cascading effect where problems are compounded throughout the project development cycle. A checklist of causal factors from various literature sources (Hofman *et al.*, 2017; Brockman, 2014; Gardiner and Simmons, 1992; Liew, 2017; Symonds, 2011) is shown in Table 4. This list and the definitions are intended for use in project specific workshops and can be modified as needed.

The RIM (Table 5) is an adjacency matrix created by combining the most detailed level of intangible risks from the IRBS and the list of risk causal factors. The RIM provides a way to address system complexity by providing a means for mapping multiple events interacting with multiple risk factors. Additionally, it provides a means to address the topic of behavior in a structured way. The Level 2 risks from the IRBS (e.g. conceals weakness and mistakes) are listed along the *x*-axis (IRF1, etc.) and the agreed causal factors are listed along the y-axis (RT1, etc.). The RIM is used in risk workshops with project teams to identify the events that

Table 2.
General project risk frameworks

Acronym	Definition
PESTLE	Political, economic, social, technological, legal and environmental
STEEPLE	Social, technology, environmental, economic, political, legal and ethics
SPECTRUM	Sociocultural, political, economic. competitive, technology, regulatory, uncertainty and market
TECOP	Technical, environmental, commercial, operational and political
VUCA	Volatility, uncertainty, complexity and ambiguity

Source(s): Authors' own work

Level 0	Level 1	Level 2
Intangible risks	Absence of trust	Conceals weakness and mistakes Hesitates to ask for help or provide constructive feedback Jumps to conclusions about intentions of others without trying to clarify them Fails to recognize and tap into others' skills and experiences Wastes time and energy managing behaviors for effect Holds grudges Finds reasons not to engage meaningfully
	Fear of conflict	Holds ineffective meetings Creates environments where back-channel politics and personal attacks thrive Ignores controversial topics critical to team success Fails to tap into all the opinions and perspectives of team members Wastes time and energy with posturing and interpersonal risk management
	Lack of commitment	Creates ambiguity among the team about direction and priorities Misses deadlines and opportunities because of excessive analysis and delay Breeds lack of confidence and fear of failure Revisits discussions and decisions again and again Encourages second-guessing and distancing among team members
	Avoidance of accountability	Creates resentment among team members who have different levels of performance Encourages mediocrity Misses deadlines and key deliverables Places undue burden on the leader as the sole source of discipline
	Inattention to results	Stagnates/fails to grow Rarely is proactive Loses achievement-oriented staff Encourages individuals to primarily support their group or themselves Is easily distracted and inwardly focused

Source(s): Authors' own work

Table 3.
IRBS translated from Lencioni's "the five dysfunctions of a team"

are likely to instigate an intangible risk factor in the project's particular context. Once complete, the RIM provides a perspective of the extent to which the risk causal factors influence risk events (Cox and Parsaei, 2021). Some of the causal factors can be caused by shortcomings in corporate policies and procedures, while others stem from behaviors (Barber, 2005; Isabella, 1992).

5. Meta-network development and network measure identification

The meta-network is a framework that is useful in representing the interactions among various networks. The fundamental building blocks of networks are nodes that can represent tasks, agents, information, resources, etc. in organizations, and their interactions are referred to as links (Carley, 2002). An advantage of this approach is the ability to analytically quantify and visually display complex behavioral interrelationships (McCulloh and Carley, 2008). Human behaviors and mental frameworks are themselves dynamic nonlinear systems (Afraimovich *et al.*, 2011). This accentuates the importance of understanding intangible factors that influence a project in ways that are difficult to quantify. These risks can manifest

Causal factor	Definition
Lack of management commitment	Ongoing active support is not obvious to the project team
Improperly defined priorities	Lack of clear management directive exists on the priorities for project team
Poorly defined roles and responsibilities	Stakeholder roles and responsibilities are not clearly defined, communicated and agreed
Team weakness (composition)	Required skillsets on the project team are missing/inadequate
End-user expectations	The end-user has clearly communicated and documented conditions of satisfaction and changes must be mutually agreed by impacted stakeholders
Inappropriate risk tolerance	Delays are caused by reluctance to make necessary decisions
Misaligned/overlapping objectives	A stakeholder's objectives intrude on or are opposed to those of other stakeholders
Undefined objectives and goals	A lack of complete clarity exists regarding project objectives and goals
Poorly defined scope	Scope is not properly detailed for effective delivery
Inadequate/vague requirements	Requirements have multiple interpretations or lack necessary details
Competing priorities	Stakeholder groups' priorities are misaligned or in conflict
Poor communication	Channels of communication are ineffective
Culture	Project context is conducive for project team to succeed
Lack of necessary authority	Authority is not commensurate with responsibility
Business politics	Specific interests take precedence over what is best for the business or power is challenged
Interpersonal conflict	Conflict has gotten personal and creates adverse implications for the project
Lack of organizational support	Project needs are not acknowledged by organization

Source(s): Authors' own work

Table 4.
Causal factor checklist

	IFR1	IFR2	IFR3	IFR4	. . .	. . .	IFRx
RT1	x						
RT2				x			
RT3		x		x			
RT4	x		x				
RTy	x		x	x			

Source(s): Authors' own work

Table 5.
RIM example

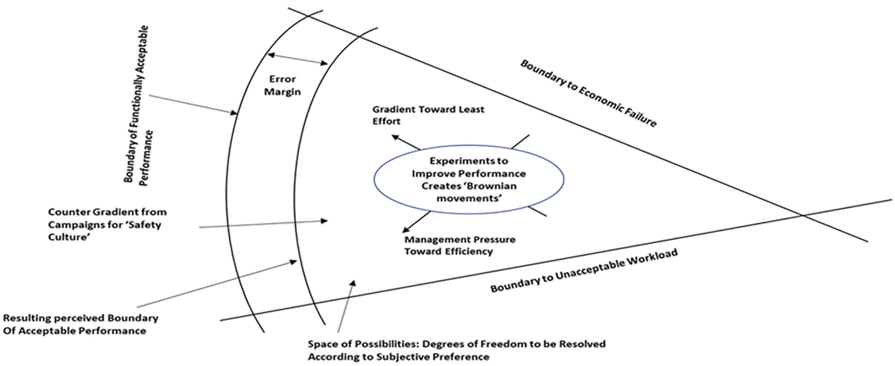
themselves in human interactions, such as ability to adapt, appropriate application of experience, communication, cooperation, culture, teamwork, relationships, leadership and conflict resolution.

DeLaurentis proposed taxonomy for a system of systems as "connectivity, heterogeneity, and autonomy of the component system." Visually, he presented this system of systems in a three-dimensional (3D) vector space with the connectivity axis ranging from "fully independent to fully interdependent," the heterogeneity axis extending from "fully technological to fully human-based," and the autonomy (or control) differing from "fully centralized to fully autonomous" (DeLaurentis, 2008). This taxonomy can be applied to socio-technical systems like projects or plant operations where agent activities follow similar patterns of independence to interdependence. The interface with technology can be fully automated or fully manual and various activities or operational states can range the spectrum of centralized to autonomous. Rasmussen's dynamic model of safety and system performance is a similar bounded system where the management's drive for cost efficiency and the worker's response to additional workload interact and move toward a technical limit of safe operation. It is within this 3D vector space where the nonlinear implications of human behavior emerge.

Rasmussen was interested in the question, "Do we actually have adequate models of accident causation in the present dynamic society?" His methods to assess safety were based on structural decomposition rather than functional abstraction. His approach conceptualizes the interaction between human and machine as a dynamic model of safety and system performance. His framework (Figure 1) is a troika of constraints (economic, workload and performance), with operating points being influenced by management pressure for efficiency and working level response to workload implications. However, the working level responds to efficiency pressure by subjective preferences, creating emerging Brownian movements within a space of possibilities. As the operating point enters the error margin, the activities associated with the safety culture act as a countervailing force. Should the operating point breach the boundary of functionally acceptable performance, a major accident is instigated (Rasmussen, 1997).

Rasmussen's conceptual model is consistent with Maier's abstraction of management control (Maier, 1998). Maier's management dimensions of directed, collaborative and virtual governance are mirrored by Rasmussen's conceptualization of safety performance as economic- and workload-induced Brownian movements. The subjective preferences of operations personnel move the operating point toward the boundary of functionally acceptable performance. If this boundary is breached, then a large-scale accident occurs.

Like plant operations, projects face financial, workload and performance boundaries. Rasmussen's model can be extended to projects where the boundaries are commercial performance in terms of cost, schedule and scope; human performance in terms of workload, adequate competent resources, workflow and procedure; and acceptable project performance – if the boundary is violated, then the project objectives are adversely impacted. Rasmussen pointed out that "idiosyncratic and unpredictable" behaviors can lead to a seemingly innocuous decision to deviate from a standard activity, which can lead to a catastrophic event (Rasmussen, 1997). Interestingly, his statement conforms to the generalized risk statement structure, "Because of <one or more causes>, <risk> might occur, which would lead to < one or more effects>" (Hillson, 2006). To address the "idiosyncratic and unpredictable" Brownian movements, intangible risk in projects can be conceptualized as a dynamic network of networks made up of the following entities: (1) people involved in the project throughout the development cycle or stages, (2) deliverables or tasks, (3) intangible risk factors and (4) events or conditions that can cause the risk to occur. Building upon Zhu's (Zhu, 2016)

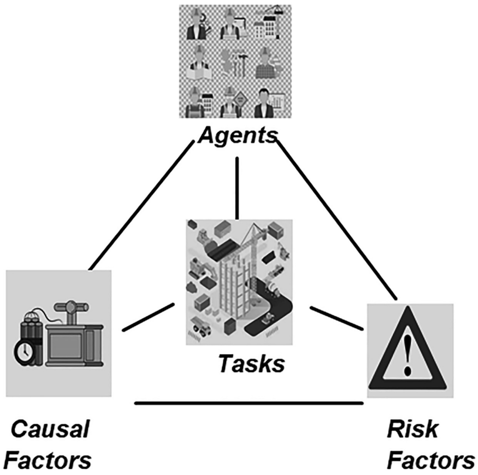


Source(s): Rasmussen (1997), used with permission

Figure 1.
Dynamic model of safety and system performance

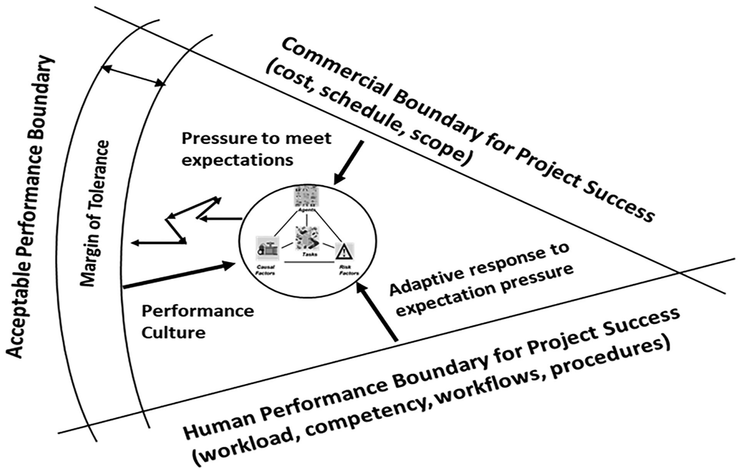
conceptualization of a project as a network of networks intangible risk in projects is described as the interaction of agents (stakeholders), project tasks, intangible risk factors and the factors that can cause them. This intangible risk conceptualization is shown in Figure 2 below.

Extending Rasmussen's dynamic model of safety and system performance to project performance and incorporating the conceptual model identified in Figure 2 is shown in Figure 3. Movement in the space between the boundaries is driven by the interaction of multiple systems – human agents, tasks, causal factors and intangible risks – being influenced by boundary conditions and culture. The intangible risk conceptualization is subject to the "idiosyncratic and unpredictable" behaviors in Rasmussen's model.



Source(s): Modified from Zhu (2016)

Figure 2.
Conceptual model of project intangible risk interaction



Source(s): Modified from Rasmussen (1997) and Zhu (2016)

Figure 3.
Extension of dynamic model of safety and system performance to project performance

The proposed meta-network (Table 6) comprises interconnected networks, providing a framework to assess the emergence of intangible risks in the project context. These networks represent the interactions among the four elements: agents (stakeholders), intangible risks, causal factors and tasks. The development of each of the networks relies on input from the IRAMP, stakeholder feedback and a project-specific document. However, depending on the unique context of the project setting, some of the networks may not be relevant.

Social Network Analysis (SNA) is a discipline that investigates how different groups are connected and the frequency of those connections. These groups can be people, computers, ecosystems, or electrical power plants and each of the individual members of the group is represented as a node. The connections in SNA terms are identified as links, so the networks formed by nodes and links can be country clubs, the Internet, or a regional power grid, regardless of the network understanding how they are to connect; the frequency of connections is foundational for understanding the behavior of networks (Barabási, 2016).

In networks, there are nodes with varying levels of importance or influence. For instance, in a country club, some members sit on an advisory board with high influence, while others are rank-and-file members. In this context, the board members can disseminate information more efficiently than ordinary members. These nodes can be viewed as having a differing degree of centrality and several measures have been developed to identify a node with potential influence based on the number of inflows or outflows as compared to other members of the network (Rodrigues, 2019). The algorithms to calculate these measures are an outgrowth of graph theory and calculate the importance of a given node within a network There are several measures of network centrality; those applicable to intangible risk in projects are highlighted in Table 7.

6. Case study

This framework was applied in an internal organizational assessment for a multi-national energy firm that will be referred to as OilCo for the purposes of this study. OilCo's project delivery performance was not meeting executive management's expectations regarding cost and schedule. OilCo's delivery performance is illustrated in Figure 4, with the dashed rectangle highlighting the acceptable zone of delivery variance. Oilco was chosen for this case

	Agent	Causal factor	Intangible risk factor	Task
Agent	Communication network: who interacts with whom	Activation network: who "lights the fuse"	Influence network: who is likely influenced by which risk factor	Assignment network: who is involved (input/review) in which task
Causal factor		Dependence network: factor-to-factor interaction	Inducement network: causal factor influences on intangible risk	Impedance network: causal factor impact on task
Intangible risk factor			Correlation network: which risks are mutually exclusive and which interact with other risks	Contagion network: which tasks are impacted by which intangible risk
Task				Interaction network: task to task interaction

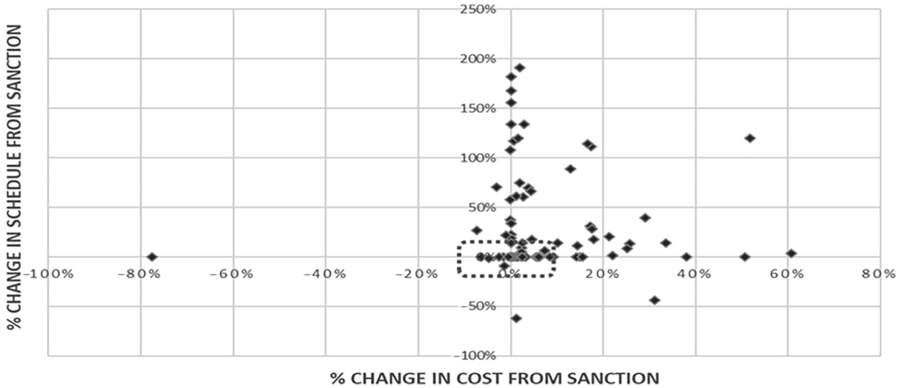
Source(s): Authors' own work

Table 6.
Meta-network

SNA measure	Description	Use in intangible risk assessment
Total degree	Number of total links (inputs and outputs) to other nodes in the network. These have a broader understanding of the current and emerging ideas, thoughts, beliefs, etc. The higher the value, the larger the role of the node	Identifying an agent's level of involvement and access to information regarding the "pulse" of the network
Betweenness	How often a node appears as a bridge between nodes in the network. These actors facilitate efficient knowledge transfer, coordinate effort, or ensure inclusion of people on the periphery	Identifying actors who are important for effective information flow and can become effective "brokers." Additionally, they can be instrumental in building trust among groups that do not normally interact
Boundary spanner	The degree that a node spans disconnected groups in a network	Identifying actors who are in key structural positions capable of spanning organizational boundaries (departments)
Eigenvector	A measure of the node influence on the entire network by having many connections to nodes with many connections	Identifying nodes that have the potential to underpin a network cascade. This can be effective in communication or propagation
Out degree	Number of links to other nodes (outputs) in the network. The larger the number, the higher the effect	Identifying actors contributing to the completion of a task and/or influencing intangible risk causal factors, along with which causal factors potentially influence the largest number of intangible risks
In degree	Number of links from other nodes (inputs) in the network. The larger the number, the higher the effect	Identifying the causal factors and tasks most influenced by actors, as well as which intangible risks are influenced the most
Cognitive demand	Measures the effort to perform tasks; the removal of this link can cause significant disruption	Identifying the workload responsibility for each agent

Source(s): Authors' own work

Table 7.
Network analysis measures of centrality



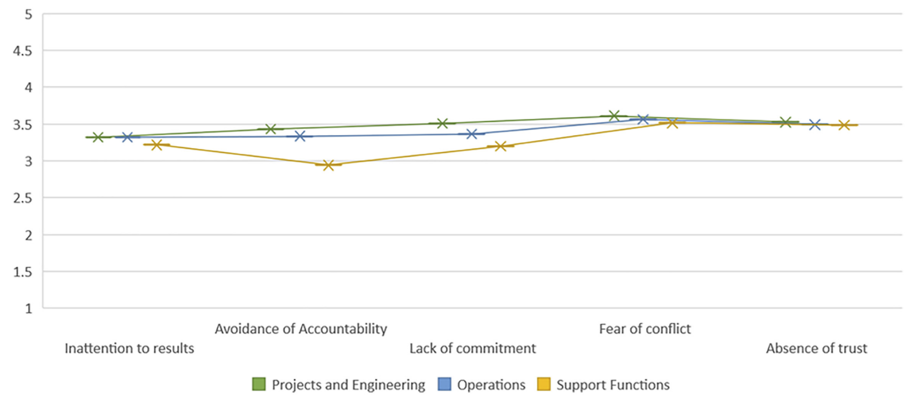
Source(s): Authors' own work

Figure 4.
OilCo major project performance

study for several reasons: (1) the international composition of the project portfolio, (2) the diversity of the workforce (comprised of individuals representing multiple countries and cultures) and (3) strong support at the executive level provided access to key individuals and information.

Structurally, OilCo is organized along functional lines, and while responsibility for project delivery is delegated to the supervisory and middle-manager levels, authority for all decision-making lies completely with senior and executive management. Within OilCo the key stakeholder groups influencing project performance were the project execution division, the operations division and the finance division. These factors created a situation where the middle managers, supervisors, project teams and other staff members found themselves being responsible without the ability to formally influence other stakeholder groups. Individuals would respond in a professional manner to objective technical information with discussions focusing on the assumptions leading to the result. However, in the more subjective area of interpersonal interactions the individual stakeholder's personal and cultural backgrounds made discussions more complicated. Consequently, directly addressing the more behavioral centric or intangible causes of project performance were avoided. This complex social-technical setting provided ample opportunities to address the study questions. In the final organizational assessment presented to OilCo executive management all the SNA measures shown above in Table 7 were used to support the study conclusions and recommendations. However, in this paper we will focus on two, Cognitive Demand and Boundary Spanner, that were of particular importance regarding empowerment of the supervisory and middle management levels to address project delivery opportunities.

Initially, thirty semi-structured interviews with stakeholders from multiple levels across the entire organization were used to identify causes for the performance gap. Comments regarding behavior were more prevalent (e.g. conflict, lack of teamwork, lack of effective communication) than concerns regarding proficiency of skills and processes. These findings were presented to executive management along with the IRAMP framework and approval was given to develop and perform a survey to assess the intangible factors. The survey contained 20 questions based on the IRBS and was distributed to 950 individuals from the key internal stakeholder groups and had a response rate of 70%. The results of the survey are shown in Figure 5 and indicate that all rating were in the range of "neither agree nor disagree". Considering OilCo's organizational context all the behavioral dimensions were seen as needing to be assessed in more detail from the three key stakeholder groups. Based on this feedback, a meta-matrix template was developed, along with a list of 30 causal factors from the literature. This information was reviewed with SME focal points from the various stakeholder organizations.



Source(s): Authors' own work

Figure 5.
Survey results comparison by key stakeholder group

Three active projects (P1, P2 and P3) were selected to utilize the IRAMP and meta-network analysis to identify and quantify the intangible risks and their causal factors. Each of these projects were at various stages of development and were managed by different project teams. P1, in the feasibility/concept stage, is a >$200-million processing plant upgrade. P2, in the front-end engineering design (FEED) stage, is an >$500-million new gasoline infrastructure (pipelines, storage and distribution facilities) installation. P3, in the execution stage, is a >$100-million offshore production facility installation on an existing structure. Using this approach provides a view of the risks at a particular time and cannot completely identify how the risks either emerged or how they will cascade in future stages of development, but it is not without some level of precedent. Thamhaim and Wilemon surveyed 100 project managers regarding conflict and conflict resolution during the project development cycle without controlling for specific project feedback in their study addressing conflict during the varying stages of project development cycle (Thamhaim and Wilemon, 1975). Workshops using the IRAMP were held with members of each project team and other key stakeholders to identify the intangible risks and causal factors in their project environment, the results are shown in Table 8.

Once the IRAMP information was collected the adjacency matrices for the meta-network simulation are developed. In addition to the IRAMP project responsibility matrices, corporate organizational charts and the three project work breakdown structures are used to develop the subnetworks. Table 9 summarizes each of the subnetworks within the meta-network along with the source of the required information. For example in the communication subnetwork (agent × agent) each of the personnel identify who they

P1 (feasibility/concept)	P2 (FEED)	P3 (execution)
Risks	*Risks*	*Risks*
– Finds reasons to avoid meaningful engagement – Wastes time and energy with personal risk management – Misses deadlines and opportunities because of excessive analysis – Revisits discussions and decisions often – Encourages individuals to firstly support their group or themselves	– Holds grudges – Finds reasons to avoid useful engagement – Misses deadlines and opportunities because of excessive analysis and delay – Is rarely proactive	– Finds reasons to avoid useful engagement – Fails to tap into all perspectives – Encourages second-guessing and distancing among team members – Refuses to bear an extra burden even to benefit OilCo
Causal factors	*Causal factors*	*Causal factors*
– Culture (punitive) – Ineffective decisions – Key stakeholder misalignment	– Lack of clear goals and objectives – Lack of active management support – Poorly defined roles and responsibilities – Inadequate or vague requirements (scope) – Ineffective communication	– Priorities not properly defined or agreed upon – Poorly defined roles and responsibilities (delegation of authority) – Key stakeholder misalignment – Inability to change or to accept change

Source(s): Authors' own work

Table 8.
Top intangible risks and causal factors

Table 9. Subnetwork adjacency matrix data sources

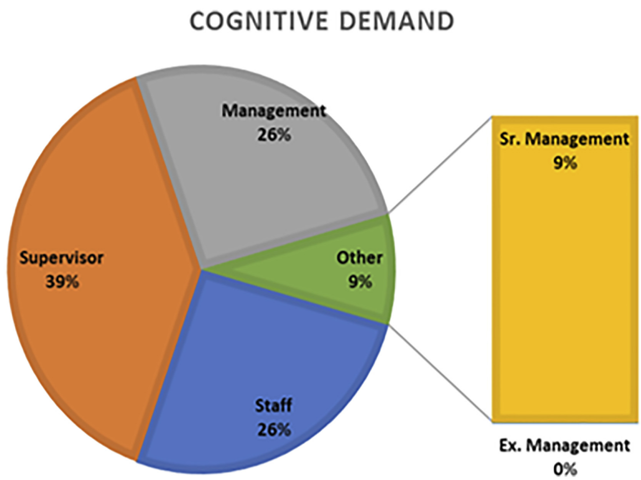
Network	Information source
Agent × agent	Organization charts and stakeholder workshop
Agent × causal factor	Stakeholder workshop
Agent × intangible risk factor	Stakeholder workshop
Agent × task	Responsibility matrix
Causal factor × causal factor	Stakeholder workshop
Causal factor × intangible risk factor	RIM
Causal factor × task	Stakeholder workshop
Intangible risk factor × intangible risk factor	Stakeholder workshop
Intangible risk factor × task	Stakeholder workshop
Task × task	Work breakdown structure

Source(s): Authors' own work

interact with and this information in entered into the adjacency matrix as either a "1" (interacts with a particular person) or "0" (does not interact). The subnetwork adjacency matrices were developed in excel and uploaded to the ORA-PRO dynamic network analysis software.

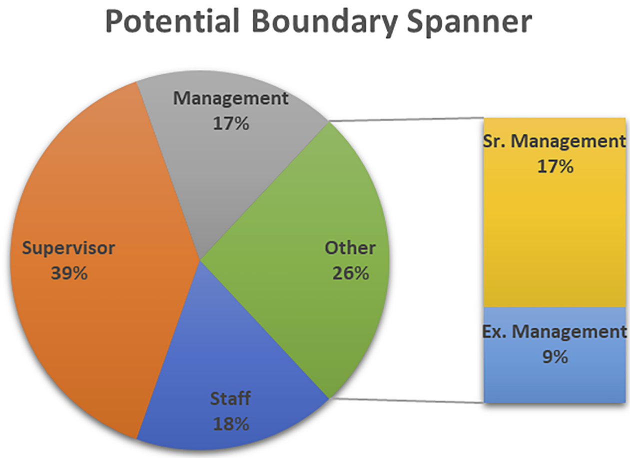
The challenge of responsibility without authority, lack of teamwork, communication and their impact on project effectiveness was a consist theme in all project workshops as causal factors for intangible risks. While there were many challenges identified two will be used to highlight the approach: responsibility without authority and teamwork measured by the measures of Cognitive Demand and Boundary Spanner. The adverse implications of responsibility without authority on project performance have been widely discussed in the literature and are considered one of the main reasons for projects failing to meet their objectives (Peck and Casey, 2011). However, there is not a method present in the literature to provide an objective assessment of responsibility without authority. In this case study, testing for the presence of responsibility without authority was defined as cognitive demand by organizational authority level (e.g. executive level, senior-manager level, manager level and supervisory level), where cognitive demand is the effort expended by an agent to accomplish their tasks related to project activities. In OilCo, the average cognitive demand score for the manager and supervisory level was twice that of the executive and senior-manager levels. Figure 6 shows 65% of the effort for task accomplishment being expended by the supervisory and management levels – without formal authority beyond staff assignments. This information was used to reassess delegations of authority to appropriately align them with project responsibilities.

The OilCo organizational structure can be described as functional silos, with information moving vertically upward to the management level (or above), then horizontally across and finally vertically downward in the targeted division. This type of formality is not conducive to establishing a sense of team connectivity. The network measure of boundary spanner identifies the agents best placed to connect unconnected groups. The supervisory level was shown to have the highest level of connectivity across the organization and to be best placed, along with the staff, to foster teamwork. Figure 7 highlights the supervisory and staff levels having the greatest ability to create bridges between the stakeholder groups. This information was used to identify organizational practice adjustments specifically addressing the ability to empower the supervisory and middle management levels to bridge the communication gaps in the organization. This move has the potential to enhance project teamwork and enhance project outcomes.



Source(s): Authors' own work

Figure 6.
Project cognitive demand by authority level



Source(s): Authors' own work

Figure 7.
Boundary spanner by authority level

7. Discussion

It is broadly held that culture impacts project performance, but what is less well understood are the behavioral impact mechanisms and consequences, along with their causal relationships. The emergence of these intangible risks can lead to interpersonal friction or what Roth and Senge refer to as "wicked messes" (Roth and Senge, 1996). If left unchecked, they have the potential to result in a cascading effect where problems are compounded throughout the project development cycle. Flyvberg found that many project failures are caused in part by human behaviors. Lückmann and Färber identified trust as being one of the most significant impact factors for project management in the intercultural context. The ability to assign a risk exposure from politics, culture, or the interpersonal conflicts stemming from them is much more difficult to quantify and "require[s] a greater degree of subjectivity and intuition" (Basu, 2017). The international project context creates added complexity due to the variety cultural backgrounds represented by the stakeholders.

The circumstances surrounding OilCo's project performance provided a "natural laboratory" to address the study questions. The supervisory and middle management levels within the project organization were accountable for results but did not have the authority to make decisions or require staff from other divisions to fulfill project requirements. However, senior management did not recognize this as a pressing issue and viewed and comments about responsibility and authority as "complaining". Many times, the various stakeholder departments had differing views of project requirements or differing political objectives. In this type of environment, dysfunctional behaviors can emerge (Beringer *et al.*, 2013; De Jong *et al.*, 2016; Lencioni, 2002). Based on feedback from the project team workshops, the supervisory and manager levels had been reluctant to raise issues over concern of being viewed as not doing their jobs or attempting to improperly influence stakeholders from other groups. However, this reluctance creates delays in solving issues or finalizing decisions and ultimately impacts project budgets and schedules.

Cognitive demand measures the total amount of effort expended by each individual or agent to perform the tasks in their remit. Figure 6 indicates almost two-thirds of the task effort is expended by the supervisory and management levels creating a conundrum regarding project responsibilities and authority. Linking the cognitive demand load of the supervisory and middle management level to their responsibilities and authority levels provided a strong foundation to discuss organizational modifications that could potentially enhance project delivery. Communication with OilCo was required to travel vertically upward to the senior management level (or above), then horizontally across to the same level in the other organization and finally vertically downward in the targeted audience. This type of formality is not conducive to timely decision-making or establishing a sense of team connectivity. The network measure of boundary spanner identifies the agents best placed to connect unconnected groups. Figure 7 identifies the management and supervisory levels having more than double the connectivity of the senior and executive management across the organization and is best placed to enhance communication and foster teamwork. Again, this provided a strong case to revisit the corporate communication philosophy. Based on this work OilCo implemented changes to its organizational structure to better align responsibility with levels of authority and empower the supervisory and middle management levels.

Interestingly, all stakeholders understood the need to address these intangible behavioral issues, but having such discussions was viewed as politically unacceptable. The IRAMP framework was well received because it was viewed as an unbiased process giving a "voice" to the organization in an apolitical setting. The structured approach to addressing intangible risks and their causal factors created an opportunity to align management and project teams in proactively addressing the threats and opportunities impacting project delivery. The facilitated workshop format provided an opportunity for stakeholders to better understand the perspectives of others and many of the participants felt the process was as beneficial as the results. The intangible risks and causal factors identified in the workshops and consolidated in the IRAMP for the different phases of the project cycle provided the executive and senior management insights. These included issues regarding misalignment of stakeholders, the need for a more active role from the senior management levels in project development as well as the need to clearly communicate requirements and project priorities.

The use of this portfolio to assess intangible risks and their causal factors may be subject to criticism. Recognizing that behaviors are the product of socio-technical interactions in a particular environment (Rasmussen, 1997), three different project settings with different stakeholders do not provide a consistent picture of how the behaviors and causal factors systematically emerge. This is a reasonable challenge; however, given the time frame for the organizational assessment (one year), it was not possible to follow individual projects for their entire life cycles. However, the use of recognized network analysis measures provided an acceptable basis to address intangible risks. The use of these indicative objective measures led to dispassionate conversations about solutions and the prioritization of risk response activities. Specifically, the use of cognitive demand and boundary spanner in the project context helped to address the sensitive issues of responsibility without authority and efficient communication. The executive management team viewed the results and identified opportunities sufficient to make organizational adjustments.

8. Conclusions

It is not intellectually difficult to spot dysfunctional behavior in project stakeholder groups however addressing them can be due to their subjective nature. The use of the IRAMP, meta-network analysis and social network analysis measures can provide an objective basis to address them in a highly diverse and complex socio-technical project setting. Using this approach to assess behavior-centric intangible risks and their causal factors can highlight opportunities to address organizational issues influencing project delivery. The use of recognized SNA measures creates this objective foundation upon which organizations can explore solutions and prioritize risk response activities thus enhancing alignment and communication among stakeholders. Finally, these measures can be used as benchmarks and the basis for lessons learned in future projects.

This work contributes to the field of risk management in several significant ways. It introduces IRAMP as a new empirically based framework for the identification of intangible project risk throughout the development cycle. It also pioneers the inclusion of intangible risks and the conditions that cause them in a meta-network construct, creating the ability to use dynamic network simulation models. Network analysis measures are identified for use in quantifying the implications of events and their influence on intangible risks. These quantitative measures identify relationships within the meta-network and the implications of making modifications. The ability to make the subjective more objective enhances the overall effectiveness of the risk management process.

While this study provided robust results in the OilCo case study, several limitations must be considered for future applications. First the empirical information came from a single corporate project portfolio with a distinctive culture and may not be appropriate for broad application. The information regarding the intangible risks, their causal factors and the agent interactions by stage was collected from three different projects with completely different teams. This approach cannot accurately reflect how these risk and causal factors emerge from individual project stage to individual project stage or how other project teams in different settings would react. Also, the meta-analysis was limited to the three projects and may not accurately represent the overall portfolio dynamic.

Because of these limitations future work could focus on a longitudinal study looking at a range of energy firms and their portfolios to provide a more diverse dataset for assessing the IRAMP and the network assessment measures. The opportunity exists to investigate other cognitive frameworks that can be better tailored to a firm's specific circumstances. This will require transdisciplinary cooperation with organizational psychologists to develop a diagnostic rubric. Other potential research paths include incorporating behavior-centric intangible risks and their causal factors in strengths, weaknesses, opportunities and threats (SWOT) analysis for the enterprise level business planning or process reengineering. Finally, there are the implications of artificial intelligence on intangible risks and causal factors. Higher cognitive skills and creativity will be required, along with more emphasis on effective teamwork. This requires a conducive workplace and an appropriate leadership style linking it to the research stream of cognitive diagnostic frameworks. This underpins that our "projectized" is likely to face increasing socio-technical challenges.

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