CHARACTERISTICS AND ENABLERS OF TRANSPARENCY IN PRODUCT DEVELOPMENT RISK MANAGEMENT

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Abstract

Risks in product development lead to schedule and cost overruns and poor product quality. While many risk management frameworks have been published and research on specific practices has been conducted, little is understood of key characteristics of successful risk management in product development and how they manifest in real development projects.
This research consists of two phases. The first phase is a survey on 171 best practices in risk management. Analysis of over 200 responses from industry practitioners identified transparency as a key characteristic of successful risk management in product development. Due to the limited exploration of the concept of transparency in the literature, the second phase of this work consisted of a qualitative investigation of transparency through interviews with 15 industry practitioners. Analysis of the interview results suggests a hierarchical structure which decomposes transparency into several characteristics and identifies enablers for each of these characteristics.
We propose that transparency can be a valuable lever for product developers and managers. Future work is needed to validate the generalizability of the observations provided.

Keywords: Communication, Organisation of product development, Risk management, Transparency, Interviews

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1 INTRODUCTION

Developing a commercial product is a process wrought with uncertainty in suppliers, requirements, market, information quality, and more. This uncertainty and the negative effect of its associated risk can lead to schedule and cost overruns and poor product quality. Risk management, in a version modified from its original application in the financial markets, has been an increasingly common approach to identify and mitigate product development risks on projects. Alongside industry's growing interest and uptake in risk management, we see a growing collection of risk management guidelines and academic literature, some that are aimed at specific industries, and others that assert universal applicability. The guidelines are typically made up of commonly accepted heuristics for conducting risk management at a large commercial firm; we imagine that these heuristics stem from the thoughtful reflection of experienced practitioners and built-up wisdom. Yet little research has been done to empirically explore and evaluate real risk management in product development organizations, or to understand in detail the mechanisms by which risk management works.

This work seeks to identify and carefully examine a previously unexplored characteristic of successful risk management in the product development context. First, we analyse data from a detailed survey of risk management in product development, which tests the association between successful outcomes and risk management characteristics. The evaluation of the survey results highlights a previously unexplored concept in product development risk management, that of "transparency". We then examine this concept in greater detail through interviews with product development practitioners and propose a hierarchical structure which decomposes transparency into several *characteristics* and identifies *enablers* for each of these characteristics.

2 LITERATURE

2.1 Empirical studies of risk management

With the growing number of risk management guidelines available to practitioners, more work is needed to empirically study the use and effect of risk management practices in product development. Those studies that do exist tend to focus on describing risk management use; those that draw conclusions between risk management practices and project outcomes are highlighted below.

This study aims to enhance this literature by providing an in-depth empirical description of a risk management practice associated with positive product development outcomes.

A study of 700 project managers explores the effectiveness of risk management practices that reduce risks in project management and lead to project success (Zwikael and Ahn, 2011). The analysis found that risk was negatively correlated with project success, but that effective risk management planning could moderate the effect of those risks. Actionable findings towards effective risk management included the suggestion that risks should be discussed openly with relevant stakeholders. This final point pertains to the idea of transparency, which is further discussed in the next section. A survey of 175 risk management professionals, focusing on project management risk, found that project success occurred more frequently with greater senior management support of risk management, actual practice of risk management practices, and regular risk monitoring (Voetsch, 2004). In another study, the authors show that risk management strategies aimed at technological, organizational, and marketing risk factors contribute both individually and interactively to the performance of new product development (Mu et al., 2009).

2.2 Transparency in risk management

Transparency is a popular topic in the academic worlds of monetary policy, international business and corporate governance, but has been explored less in the product development community.

The findings of Chapman and Ward (2004) are particularly relevant to this discussion of transparency in product development risk management. Best practice in project risk management is said to require the elimination of "dysfunctional 'corporate culture conditions' like 'a blame culture' which fosters inappropriate blame." The authors argue that best practice cannot be achieved without understanding of – their term – risk efficiency and use of cumulative probability distributions to pursue it.

A large body of literature exists on the topic of information processing with management applications, as presented in the review of Moorman (1995). This literature is informative and thought-provoking on the subject of transparency, but is not immediately applicable to transparency as it relates to risk

management in product development. Another study explores the effect of information, or lack thereof, on project managers' decision-making (Bendoly and Swink, 2007). The study concludes that greater visibility of situational information impacts project outcomes by affecting the decision maker's actions and perceptions regarding the behaviour of others and the priority of the decision maker's task. These findings can be interpreted to suggest that transparency would work via a similar mechanism to impact product development outcomes. Unreported information is explored in a study of how choices are made on the relevance of risk information (Kutsch, 2010). This work specifically explores deliberate ignorance of risks through a qualitative study of IT project managers. A review of previous work on ignorance and certainty, as well as a taxonomy of ignorance, is presented in this paper. The author concludes that traditional project risk management assumes "hyper rationality" of stakeholders and thus ignores aspects of managerial behaviour, such as deliberate ignorance and judgment of relevance.

In one instance of a study on transparency in the context of product development, Wirthlin identifies five key characteristics the acquisition system values in an investigation of US defense acquisition program performance: cost, schedule, performance, transparency, and flexibility (2009). This expands on the typical view of product development as an endeavour driven purely by cost, schedule, and performance. The author identifies consensus building and desire for openness as the desirable effects of transparency. However, it is pointed out that within the Department of Defense, this transparency comes with burdensome approval and accountability functions.

In their book on project risk management, Cooper et al. suggest that transparency and traceability of risk management decisions is often a requirement established by effective senior management (Cooper et al., 2005). A case study is presented where increased transparency of risk management was achieved through online sharing of reports and studies to all stakeholders.

Transparency is featured as one of the eleven principles of managing "any form of risk within any scope and context" in the ISO 31000 risk management standard (ISO, 2009). The ISO standard claims that compliance with these principles will lead to effective risk management. These principles are as follows: (1) Risk management creates value; (2) Risk management is an integral part of organizational processes; (3) Risk management is part of decision making; (4) Risk management explicitly addresses uncertainty; (5) Risk management is systematic, structured and timely; (6) Risk management is based on the best available information; (7) Risk management is tailored; (8) Risk management takes human and cultural factors into account; (9) Risk management is transparent and inclusive; (10) Risk management is dynamic, iterative and responsive to change; and (11) Risk management facilitates continual improvement.

The standard elaborates on principle number 9, on the topic of transparency, which reads:

> *Appropriate and timely involvement of stakeholders and, in particular, decision makers at all levels of the organization, ensures that risk management remains relevant and up-to-date. Involvement also allows stakeholders to be properly represented and to have their views taken into account in determining risk criteria.*

The inclusion of transparency in the broadly applicable ISO 31000 standard reinforces the findings of the previously discussed literature regarding risk management in product development and points to a potentially fertile area for further investigation.

3 RISK MANAGEMENT SURVEY

Given the number of risk management guidelines available to practitioners, and the lack of empirical studies of actual risk management use in the product development context, we sought to first test the correlations of a number of best practices with positive project outcomes with a survey of industry practitioners. This analysis would provide some empirical evidence that would suggest a direction for the next phase of research.

3.1 Survey development and dissemination

This section summarizes the work of Oehmen and Bassler in designing the survey (2011). They developed and tested a survey on the topic of risk management in product development over a period of six months. They worked closely with a focus group consisting of twelve individuals from three academic institutions, one risk management consultancy from the aerospace sector, and six companies from the aerospace and defense sector, all based in the United States.

The development of the survey focused on pre-filtering the questions as much as possible to only include risk management characteristics and practices, as well as risks and mitigation actions, which were agreed on as being best practice or of significant impact on the risk management process by general expert and practitioner consensus. Pertinent published guidelines were reviewed and consolidated for inclusion in the survey (DoD, 2006; INCOSE, 2004; ISO, 2009; NASA, 2008; Project Management Institute, 2008). Notably for the findings of this paper, the ISO 31000 principles of risk management, as listed in Section 2.2, were each asked as questions in the survey.
The total time needed to complete the survey was approximately 45-60 minutes. The survey was administered online and distributed in two ways: First, the survey was sent to the risk management organization of a number of large aerospace and defense companies as part of a benchmarking process. Through this distribution, 90 complete datasets of the survey were collected (aerospace and defense responses composed 51% of total sample). Second, the survey was distributed to practitioners through professional organizations and mailing lists. To encourage participation by shortening the response time required for survey completion, the survey was broken down into smaller parts according to respondent function: Part 1 with questions relevant for general program managers (i.e. respondents not working in a dedicated risk management role), and parts 2 and 3 with questions relevant for respondents directly involved in risk management. The respondents that were binned into the 'risk manager' category were randomly assigned to one of the two risk management parts, with a 50/50 distribution.
In total, 375 responses of various degrees of completion were recorded over a period of seven months between March and September of 2011. Exact response rates are difficult to ascertain, as recipients were encouraged to forward the invitations to colleagues within their organization. Detailed information about the sample population and survey structure are provided in a related study (Oehmen et al., 2014).

3.2 Survey analysis and results

The survey collected extensive information (171 questions) about past projects, specifically regarding project outcomes and risk management process. The survey addressed methods and practices in the areas of risk analysis, risk evaluation, decision-making, and risk monitoring. Questions on use of practices and outcomes were asked on a five-point symmetric Likert scale, which consists of five discrete options ranging from "never" to "always" or from "strongly disagree" to "strongly agree".
The survey included high-level outcome questions which covered the traditional PD goals (success with regards to cost, schedule, technical performance, and customer satisfaction targets). Questions on outcomes were also asked on a five-point symmetric Likert scale, with options ranging from "complete failure to meet target" to "strongly exceeded our target". To simplify the description for this paper, we will focus our evaluation simply on the eleven ISO 31000 risk management principles. In related work, all 171 questions were analysed and compared in similar fashion (Oehmen et al., 2014).
We then analysed the data to see if there are any variables which correlate significantly with the outcome variables.
We tested the effect of each risk management principle on the outcome with the Effect Likelihood Ratio test. The effect likelihood ratio was calculated using the chi-square statistic, which is a test for the difference when a model includes all variables versus when the variable of interest is removed. The test measures how much more likely the outcome data is to be from one model or the other. If the p-value is non-significant (in this case, greater than $\alpha = 0.05$), then there is no statistical significance for the variable of interest to be included in the model. Table 1 lists the calculated p-values for each outcome model. Significant p-values are bolded.
Table 2 below presents a breakdown of the responses to principle 9, in the form of the question "Our Risk Management is transparent and inclusive towards all stakeholders" with the corresponding average PD Target scores (the mean of the answers, asked on a 1-5 scale). The increasing Mean PD Target Scores presented in Table 2 indicates that indeed there is a trend in the degree of transparency/inclusivity and the product development target achievement.
The results in Table 1 show that there were significant associations with project outcomes for a number of risk management principles; this finding suggests to the authors that many of these principles warrant further investigation, and we hope that future work from our community takes advantage of these statistical pointers. In this work, we chose to continue our investigation with a focus on transparency (principle 9) for two reasons: first, it shows statistical significance in a number

of outcome metrics, and second because the concept of transparency has been little addressed in the product development risk management literature.

Table 1. Explanation power of each of the eleven ISO 31000 risk management principles (see description of principles with numbered list in Section 2.2) on each of the outcomes, as represented by the ordinal logistic chi-square effect likelihood ratio p-values. Each p-value less than or equal to α = 0.05 is significant and is bolded.

Product Development Outcome	*ISO Risk Management Principle*										
	1	2	3	4	5	6	7	8	9	10	11
Cost target	0.86	**0.02**	0.87	0.12	0.22	**0.03**	0.70	0.32	0.20	1.00	0.11
Schedule target	0.63	0.18	**0.03**	**0.04**	0.24	0.16	**0.04**	0.44	0.15	0.39	0.57
Technical performance target	0.71	**0.01**	**0.03**	0.80	0.32	0.07	**0.01**	0.12	**0.03**	0.21	0.11
Customer satisfaction target	**0.02**	**0.00**	**0.00**	0.19	0.06	**0.05**	0.34	0.38	**0.02**	**0.00**	0.15

Table 2. Breakdown of 195 responses to the question: "Our risk management is transparent and inclusive towards all stakeholders." For each group of responses to this question, the mean of the four product development (PD) outcome dimensions is also presented.

"Our RM is transparent and inclusive towards all stakeholders."	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Number of responses	7	33	55	83	17
Mean of four PD outcomes	2.46	2.59	2.82	2.94	3.55

4 INTERVIEWS

The statistical results suggest a correlation between transparency and project success but do not show causation or provide explanation. A more in-depth and exploratory study was needed. The qualitative research interview method has been found to be an ideal way to examine topics where different levels of meaning need to be explored (Bouwen et al., 1994), as was the case in this study of transparency.

4.1 Method

Qualitative data was collected by means of 15 personal interviews of industry practitioners conducted both over the telephone and in person. Most of the interviews were recorded for convenience and accuracy of transcription. The interviews were performed in the United States between March and October of 2014. Each interview subject had several years of experience working in product development teams in industries such as software, civil engineering, automotive, and aerospace/defense. Typical titles included Product Manager, Project Manager, Software Engineer, and System Engineer. Extended analysis and full transcripts of the interviews are available (Shaffer et al., 2015).

4.2 Framework for analysis: Characteristics and enablers

The qualitative data obtained from these interviews were used to produce a conceptual definition of the type of transparency required for effective risk management. We see a useful grouping between two concepts within the topic of transparency: *surface transparency*, which leads to a shared understanding of information and assumptions, and *deep transparency*, which leads to alignment and trust in the team.

This was then decomposed further into a framework of *characteristics* and *enablers* for transparency in product development teams. *Enablers* of transparency are specific actions that an organization can take to encourage transparency within their teams. *Characteristics* of transparency are desired states that interview subjects directly associated with transparency and that have been observed to occur when one or more *enablers* has been successfully applied within a team.

The diagram in Figure 1 represents a possible decomposition of the topic of transparency, first into the broad groupings of *surface transparency* and *deep transparency*, and further into sets of *characteristics* with associated team behaviours. The diagram also includes several *enablers* of transparency that were identified over the course of the interview analysis.

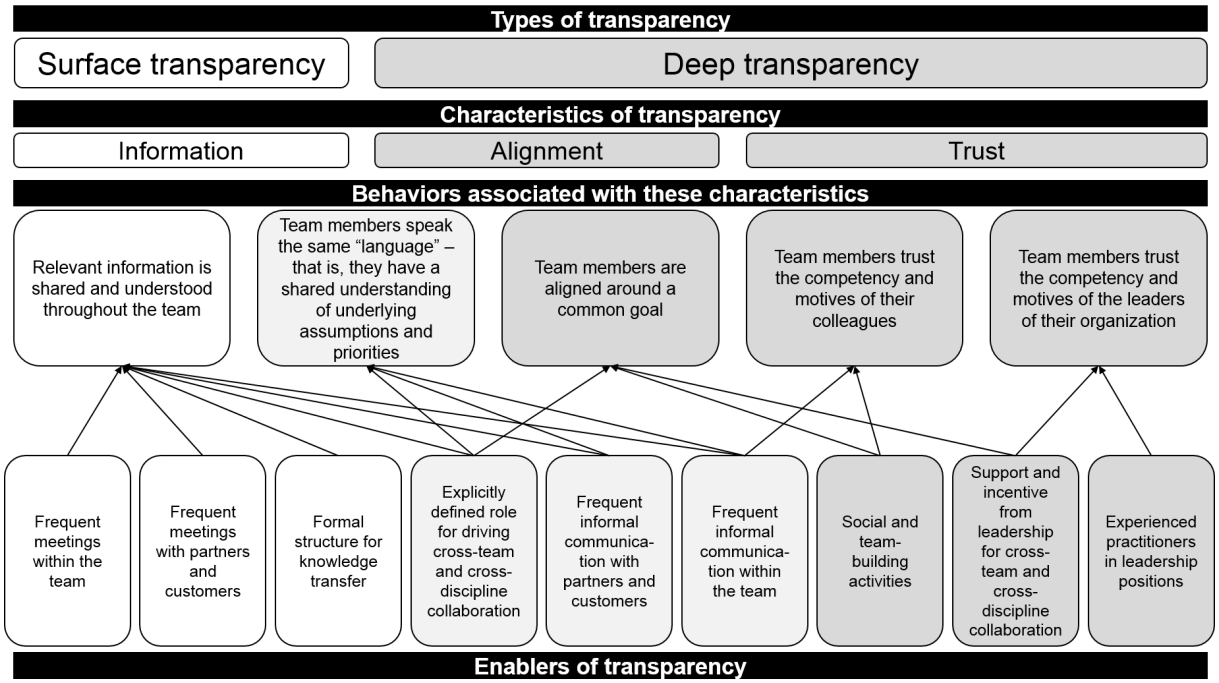

Figure 1. Hierarchical decomposition of transparency including characteristics and enablers.

Figure 1 also contains arrows that link *enablers* to *characteristics*. These arrows denote that one or more interview subjects indicated a possible cause-and-effect relationship between the *enabler* and the corresponding *characteristic*. The remainder of this section will explore each of these *enablers* in more detail.

4.3 Characteristics of surface transparency: Information and assumptions

Effective risk management in a product development process requires effective information sharing among team members. To this end, the concept of *surface transparency* can be defined as follows:

> The sharing of relevant information among members of a team or organization so that the full set of relevant information is being communicated, and so that all parties understand the information as communicated in both a literal and technical sense. This information may include items such as project status, product designs, technical data, and so forth. (Shaffer et al., 2015)

A key theme that emerged repeatedly throughout the interviews was the idea that transparency is often hindered by a lack of real understanding when two parties are attempting to communicate. Of course, there are many reasons for this in practice, but the interviews revealed two main types of understanding that are often lacking.

The first and most readily apparent type of communication problem is a lack of literal or technical understanding between two parties. This occurs most often when the parties are of differing discipline or background – for example, when engineers communicate with salespeople, or when engineers with varying technical backgrounds attempt to communicate with each other.

The second and more subtle communication issue is caused by differing underlying assumptions or priorities with regard to the product, the process, or the business. These problems can be much more difficult to solve. Often two parties will fully understand each other's literal and technical messages, but will reach entirely different conclusions because they are interpreting the data based on their own view of what is important or what is a priority for the business.

Three *enablers* that were observed to directly improve the shared understanding of information and assumptions within product development teams: holding *frequent meetings within the team*,

holding *frequent meetings with partners and customers*, and having a *formal structure for knowledge transfer* within the organization.

Enabler: Frequent meetings within the team: The most obvious method to encourage information flow within a product development team is to hold regular meetings. Various organizations use different meeting styles and formats, but most interviewees seemed to draw a correlation between frequency of meeting and degree of information flow. Generally, meeting frequencies ranging from daily to weekly seemed to be the norm for well-functioning teams, and anything less than that was indicative of poor information flow. One observed way to improve the effectiveness of information flow and mitigate the risk of misunderstanding is to establish a shared representation as a communication vehicle – that is, an agreed-upon format which can accurately represent the information such that all parties can understand it. This can take the form of a particular presentation style, a specific type of visualization, or even a demonstration of the product itself:

> *"One more interesting way we've been communicating our status lately is doing weekly status demos for the executives. ... It allows them to be a lot more engaged and claw for information rather than having it prepared and passed on to them. We've definitely identified interesting issues that we probably wouldn't have identified otherwise."*
> – Software Architect, Enterprise Software

Enabler: Frequent meetings with partners and customers: Frequent meetings within the team, while necessary, are not sufficient. Frequent communication with partner teams in the organization can also be important to the success of the project by ensuring that necessary information is flowing freely:

> *"The directors often have commitment conflicts between their own teams' sprints and the all-up director-level sprints. Individual teams try to be independent and communicate only at the director level, but this often results in deadlocks."*
> – Director of Engineering, Internet Software

Many interview subjects also noted that more frequent communication with customers, along with ensuring that their feedback is heard throughout the organization, can improve end-to-end transparency and help to ensure that all the teams and disciplines are on the same page.

Enabler: Formal structure for knowledge transfer: Another key theme that emerged from the interviews is the role that organizational structure plays in promoting effective transparency and communication between teams. Appropriate organizational structure can reinforce desired communication patterns and discourage unnecessary or destructive ones in a way that improves efficiency and transparency across the company. For example, in a well-run organization with effective managers, individual contributors rarely need to need to communicate with anyone higher up than their immediate manager.

Organizations also need to carefully consider both the communication channels and communication boundaries that are established by the structure of the team, either directly or indirectly. For example, in many companies there are inappropriate boundaries between engineers and customers that can result in miscommunications:

> *"The people doing the communication may not understand the underlying facts or products well enough. Like, if you take something, say a router ... unless the marketing person is somebody who has a decent understanding of routers, chances are he gets something altogether wrong."*
> – Program Manager, Consumer Electronics

4.4 Characteristics of deep transparency: Alignment and trust

In addition to simple information sharing, effective risk management processes also require a shared understanding and motivation among team members so that information can be interpreted correctly. To this end, the concept of *deep transparency* can be defined as follows:

> A common understanding of goals and priorities among all members of a team or organization, in addition to a shared trust among team members of each other's competency and motives. (Shaffer et al., 2015)

The literal and technical understanding that comes with *surface transparency* is a necessary precondition for the existence of *deep transparency* in a team or organization. Evidence from the interviews shows that *deep transparency* can be broadly broken into two *characteristics*. First, alignment among members of the organization is critical. People must be using the same language and working toward the same goals in order to maximize the chance of success for the project. Second,

trust among team members is important for encouraging an open and collaborative culture and to improve transparency overall.
The remainder of this subsection will describe the *characteristics* of alignment and trust in more detail, along with the *enablers* that interview subjects associated with these *characteristics*.

4.4.1 Characteristics of alignment: Shared language and shared goals

One necessary condition for true alignment is ensuring that the various team members are using common language. Without shared language, communication about priorities and goals is difficult or even impossible.

> *"Learning how to communicate means speaking the same language. You've got cross-functional teams, you've got hardware engineers talking to software engineers talking to chemists talking to managers. You're not really saying things that people understand. You aren't actually able to pick out if there's a problem."*
>
> – System Engineer, Aerospace and Defense

Having a shared language is a step along the way to true alignment, which occurs when all members of the team are working toward the same goals. This is most easily achieved when there is a single source of direction for the product development team that is effectively able to communicate with the various stakeholders in a project. The characteristics of shared language and shared goals explored here are closely related to the "trading zone" concept developed by Galison (2000).
The data from the interviews suggested at least three *enablers* that may encourage alignment within product development teams, as listed below.
Enabler: Explicit role for driving cross-team and cross-discipline collaboration: Interview subjects observed that having an explicit role in the company for people who drive cross-team and cross-discipline communication, often referred to as product management or program management, often leads to much more effective transparency across teams and disciplines. Many companies include this role as part of the product development team itself. In some cases, product managers can facilitate communication between two disciplines that otherwise may not understand each other or have incentive to collaborate:

> *"Engineering does not care about design. ... In the absence of product managers, I think that design and engineering have a real disconnect."*
>
> – Product Manager, Consumer Software

Enabler: Frequent informal communication with partners and customers: Having regular informal communication can improve the two-way relationship between the engineering team and its customers, whether internal or external to the organization. Developing these relationships through informal methods can improve the company's overall relationship with the customer by improving two-way transparency and honesty:

> *"Product managers communicated most with the consulting engineers. They were the ones who had to sell my product, so I had to give them all the information. ... You have to become their friend for them to tell you everything."*
>
> – Product Manager, Civil Engineering

Enabler: Frequent informal communication within the team: Communicating regularly in an informal style, such as by daily scrum meetings or serendipitous hallway conversations, can reduce the need for formal meetings and the overhead associated with them. This type of communication can effectively improve transparency and alignment simply because of the increased information flow:

> *"The scrum meetings were useful, especially when we were in a team of 7-12. It was really helpful to know who was working on what and to make sure that we got a sense of what we were going to have at any given time."*
>
> – Product Manager, Aerospace and Defense

4.4.2 Characteristics of trust: Competency and motives

The concept of trust was brought up in many of the interviews as a major piece of the transparency picture. Two variations of trust can be identified. The first variation involves the *explicit* decision to trust another person, whether a colleague, partner, or manager. This trust can be based on aspects such as personal experience, reputation, title, or seniority. The second, more subtle variation of trust consists of the *implicit* confidence placed in a given piece of information or data. Information obtained from an explicitly trusted source can be held as trustworthy or reliable without the need for further

verification, which can be viewed as an information exchange with greater maturity (Blanco et al., 2007). Conversely, data obtained from a source that is known to be untrustworthy cannot be used as the basis for a decision without further verification. The ability to accurately decide whether to trust a given piece of information is an interesting result of increased transparency and can be important for improving efficiency of decision-making across the team.

Trusting the competency of another person not only makes it more enjoyable to work with that person, but it can also have the effect of improving transparency and efficiency of communication.

In fact, competency and reliability were repeatedly mentioned by interview subjects as important factors in making the decision of whether to trust a colleague or a manager:

> *"Trust means competency and being able to do something about it. Trust has to be built over time. You work with someone and you see that when you bring up an issue or are blocked on something … they can go and get that smoothed out."*
>
> – Product Manager, Commercial Electronics

Interview subjects reported a wide variety of activities that may help to develop trust within teams. This information was distilled down to three primary *enablers* that have been observed to have a possible effect on trust levels within product development organizations, as listed below.

Enabler: Social and team-building activities: Developing relationships at social events may improve working relationships by encouraging more direct, informal communication rather than relying on formal methods. Getting people to an environment outside the office may allow people to be more open and thereby help to improve trust among team members:

> *"People may be more honest with you if they're not at work and feel more relaxed. They're more likely to speak up if they have a problem or an issue, when they may not normally do that."*
>
> – Project Manager, Transportation

Enabler: Support and incentive from leadership for cross-discipline collaboration: Having the appropriate organizational structure and incentives for collaboration and trust within teams can be very important to the success of product development projects:

> *"Communication is critical to the success of projects. Companies don't always recognize its importance or reward it properly, since it's more about collaborating and helping others rather than directly producing results yourself."*
>
> – Principal Software Engineer, Enterprise Software

Enabler: Experienced practitioners in leadership positions: One method observed by several interview subjects to improve transparency is the placement of technical experts in key communication and leadership roles. People with extensive industry and technical backgrounds are much more likely to interpret information correctly and prevent technical misunderstandings or miscommunications, thereby earning the trust of the engineers on the team. Designating such a person as the leader or communication hub for the team can also improve efficiency and relationships with other teams:

> *"Most engineering teams hate sitting in meetings, so it saves time for all the other people if you have somebody who can understand and extract relevant stuff out. … You project a good image of the whole team when you send somebody who is a subject matter expert."*
>
> – Program Manager, Consumer Electronics

5 CONCLUSION

This research consists of two phases. The first phase is a survey on 171 best practices in risk management. Analysis of over 200 responses from industry practitioners identified transparency as a key characteristic of successful risk management in product development. The second phase of this work consisted of a qualitative investigation of transparency through interviews with 15 industry practitioners.

The survey results provide concrete empirical evidence that there are a number of risk management principles which correlate with positive project outcomes in product development practice, though this does not reveal causation or whether the principles are independent factors. We interpret the statistical results as clues to potentially worthwhile concepts to further explore. In this case, given that it has been less frequently explored in the product development literature, we elected to focus on transparency.

The interview results offer a possible decomposition of transparency at several levels, and especially into the proposed framework of *characteristics* and *enablers*. We form a high-level grouping of these

concepts by defining "surface transparency", leading to sharing of information and assumptions, and "deep transparency", leading to mutual alignment and trust within the team. Digging deeper, we identify several *characteristics* of transparency relating to information sharing, underlying assumptions and priorities, alignment around a common goal, and trust in the competency and motives of others.

Finally, we analyse the interview data to identify several possible *enablers* that have been observed to increase the likelihood for the existence each of these characteristics, including frequent communication within and between teams, organizational support for cross-team and cross-discipline collaboration, and opportunities for informal communication and social interactions.

We present this work as a preliminary exploration of transparency and its possible benefits, which could be a valuable lever for product developers and managers. Although the beginnings of a prescriptive conclusion are present, future work is needed to further validate the generalizability, constraints, and trade-offs of transparency. Nevertheless, we hope this paper increases awareness of the enablers and characteristics of transparency and how they manifest in product development organizations.

6 LIMITATIONS

Some limitations are important to consider when interpreting the survey results. The survey is taken post-project, so accurate recollection of program details may be difficult. The analysis relies on self-reported outcomes which could be biased by the experience of the respondent. The survey was self-administered online; to address potential misinterpretation of the questions, clear descriptions and examples were included throughout the survey and opportunities were given to comment on ambiguity of individual questions. Although the sample included a diverse mix of product development projects, the empirical findings from this data set are not necessarily generalizable beyond this sample.

The potential for self-selection bias exists in our survey and interviews. Those with an already strong opinion about risk management may have been more likely to respond or participate.

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