Review

Extraction and translation of safety knowledge in organizations using incident reports

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The Incident Report-Based Safety Knowledge Transfer (IRSKT) model found in this paper identifies the elements necessary for social systems in workplaces to extract, disseminate and use new safety knowledge emanating from incident reports. The purpose of this paper is twofold: to understand how recent developments in systems thinking and materiality of knowledge can influence understanding of safety knowledge transfer (SKT); and to propose a new systems-based safety knowledge transfer model founded on incident reports. The paper is a review of the literature on safety knowledge transfer, materiality of knowledge and systems thinking; leading to the proposal of a new SKT paradigm. This paper shows that the IRSKT model is well suited to analyzing safety knowledge transfer in both complex and small-scale systems. Empirical studies in various systems (of complexity) environments will help affirm and enrich the model. The paper sees that in organizations where safety of employees is important, the ability to extract knowledge from incidents reports – which is an accessible and ready estimate of safety situations in organizations - is vital for establishing safe workplaces. The capacity for effective exchange and utilization of safety information inherent in incident reports by employees, equipment manufacturers, professional bodies and government agencies as reflected in IRSKT will inform the decisions to build in safety in machinery, better safety rules, effective safety campaigns and enhance safety conscious behaviours in organizations. The paper offers a new safety knowledge transfer paradigm that views safety knowledge as a systemic, emergent, embedded and materially entangled representation of reality. The proposed knowledge transfer model is different from earlier attempts, concentrating movement of safety information in incident reports and the significance stakeholders must attach to them to minimize both human and machine error.

Key words: Incident reports, accidents, knowledge transfer, safety knowledge, systems analysis.

INTRODUCTION

Given that an accident and the resulting incident report have the capacity to immediately call attention of stake-holders, including regulating agencies to safety issues, the significance of the report can not be overstressed. However, there is scant research attention focusing on the nature of the knowledge extracted from such reports and how it is transferred within the organization and among the stakeholders.

Furthermore, knowledge is the most important asset in organizations and nations not only because it is the prime source of wealth (Parent et al., 2007) but also because it saves lives. To increase competitive advantage, employees are required to work with increasingly complex machines and within the confines of equally complex structures (Alam, 2009). In such environments, accidents happen; and because human lives are involved in such incidents, their occurrences are taken seriously by employers, supervising agencies, manufacturers and professional associations (Tyler, 2007). To underscore such importance, legislations exist in many countries requiring organizations to record and report incidents. The mechanism by which that requirement is fulfilled is by filing incident reports (Tyler, 2007). Incident here means an accident or a near-miss.

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Every incidents associated with any kind of personal injury is required to be documented. Based on the kind of injury, its seriousness as well as implications, accidents may also be required to be reported to the associated regulating agencies. However, some accidents which do not cause any specific personal injury will likewise have to be reported. Due to the importance of such reports, organizations are usually careful in ensuring that various requirements of reporting are fully understood and complied with. It can also be crucial to preserve significant evidence on many grounds; as it may be needed for an organisation's investigation of an incident in a bid to avoid its reoccurrence (Tyler, 2007). Incident reports are used to fulfil many purposes such as feedback for safety programmes in organizations, data for insurance claims, yardstick to assess old safety rules by government agencies, and grounds for creating new ones.

The extant literature tends to focus on research findings as transferable safety knowledge. Even experts that are affiliated with safety research institutes operationalized safety knowledge as research findings. For example, among the objectives of the Robert Sauvé Research Institute on Workplace Health and Safety (IRSST) based in Canada, are to: "To add new, interdisciplinary research and KT [Knowledge Transfer] capacity related to workplace injury and permanent structures for ongoing capacity enhancement linking the participating organisations and to build a network of research and community WHS collaborators in Atlantic Canada linked to the three Québec research organisations with their established social capital of community and institutional connections, thus creating a truly Eastern Canadian regional organisation(Roy et al., 2003)" But they define "knowledge [as] research findings" (Roy et al., 2003; p. 159).

Based on this conceptualization, for knowledge to transfer there must be research preceding it. Therefore, safety knowledge is a commodity created by researchers for onward transmission to end-users. Even researchers who argue for the social contextual importance of knowledge transformation and translation do so with the belief that the social exchange has to be set off by researchers (Alam and Hoque, 2010).

Baines (2007) drawing on data collected as part of a larger qualitative study of health and safety issues in the Canadian social services sector, explain that such efforts of knowledge translation, as currently conceptualised as well as organized, is limited and also constraining by means of its very own discourse associated with research neutrality, and through the political economy regarding research institutes and also organizations which grant research funds. These entities are inclined to encourage people generating journal articles and discourage people spending time getting the research accessible to those who need it.

Still, knowledge translation is actually an increasing requirement in an increasing number of studies. Since prevention as well as intervention tends to be the specific and also preferred final results, knowledge translation has special prominence in safety studies (Parent et al., 2007). Baines argues that utilizing knowledge to enhance health and safety practice would be greater if perhaps knowledge translation was incorporated into the research methodology, specifically as an appraisal of research validity. As Baines argues, transfer of knowledge from research institutions to practice remains a problem and the effectiveness of introducing knowledge translation as a form of validity remains to be seen.

However, researchers are increasingly championing other sources of knowledge other than scientific studies e.g. the significant role of social systems in knowledge acquisition, creation, utilization and sharing.

In arguing for the inclusion of social systems in the generation and dissemination of knowledge, Parent and his colleagues (Parent et al., 2007) introduced the Dynamic Knowledge Transfer Capacity (DKTC) model which promotes a new systemic as well as generic framework to describe the parts required for social systems to generate, disseminate and utilize new knowledge to address their needs.

Parent et al. (2007) work is quite significant; since, by employing a functional relation of parts to the whole as inherent in systems-thinking to knowledge transfer, it becomes clear that knowledge transfer is connected with the relationship between and within systems. However, their model is built on the three pillars of needs, goals and processes with needs being the most fundamental; believing that when there is need for knowledge in social systems, such knowledge will be generated (Alam et al., 2010). This notion ignores the fact that useful knowledge can be created even before the need is discovered. For example, an accident in an industrial setting can provide useful information to employees on how to tackle similar tasks or machine that caused the accident in the future; such knowledge will be generated prior to any demands occasioned by a need.

One of the most important works on safety knowledge translation and circulation is Gherardi and Nicolini's (2000) work. They posit that organizational knowledge is essentially a practice engaged by individuals acting together. This endeavour brings together motley of elements and agencies, including concepts, principles, artefacts, rules, individuals, standards, as well as customs and tends to be marshalled, revised, converted, altered, revealed, utilized, disregarded or even concealed because of certain pragmatic outcome, like safety within a building location.

Safety as a type of organizational know-how thus remains located within the process of continuous routines (Gherardi and Nicolini, 2000). Further, it possesses both express as well as implicit aspects. Additionally, it is connected to and intermediated through artefacts, which means, it is material in addition to being a mental representation. Using examples derived from the observation

data, the authors discuss how safety-linked knowledge is formed, transferred, as well as constantly expanded in addition to being revised inside the organizing system via the interaction involving action as well as some sort of logical relation. As significant as Gherardi and Nicolini's (2000) work is, incident report is presumably subsumed under the generic classes of artefacts and rules and therefore we are yet to know how safety knowledge is specifically extracted from incident reports.

MATERIALITY OF KNOWLEDGE

Advocates of the materiability of knowledge view knowledge as performative, not representational (Orlikowski, 2006). Thus, knowledge is not another long-lasting, or important element — rather, an active and continuous communal outcome. This is a perspective of knowing in practice that is getting significant research interest by many experts such as (Blackler, 1995; Lave, 1988; Nicolini, Gherardi, and Yanow, 2003; Tsoukas, 2005). This, points us to pay attention to knowledge that is not only static or simply constant, but like an ability created and also recreated within continual communal behaviours.

The practice perspective of knowledge drives us to recognize knowing as emergent (as a result of daily actions and therefore usually "in the making"), embodied (as apparent in this kind of ideas such as tacit knowing as well as experiential learning), and embedded (based within the socio-historic setting of people's lives in addition to work) (Orlikowski, 2002). To this specific notion (Orlikowski, 2006) contributes an additional crucial element, which is, that knowing is often material.

Daily routines along with the knowledge produced as a consequence of such interactions can be profoundly locked up within what Orlikowski called the "stuff" (forms, artefacts, settings, as well as infrastructures) around, with and within which people operate. Think of any kind of human activity, then consider the accompanying materiality. It is clear that a lot of an individual's actions are quite influenced by "stuff" like houses, equipment, vehicles, garments, spaces, furniture, electronic gadgets, stationnery, and so forth. Some "stuff" are less conspicuous like water, air, electrical energy, information as well as voice systems. Although sometimes we realize the materiality in knowing, it is seldom recognized. We realize it in the actions. Yet "on another level, the level of conceptualizing and theorizing, we tend to disregard this knowing, and render our accounts of knowledge in organizations without attention to material matters" (Orlikowski, 2006, p. 2).

Orlikowski (2006) asserts that an individual's action is not only dependent on artefacts, but that it is also formed by them. In absent the material stuff of daily existence, our actions would not be feasible. Therefore, action inevitably necessitates materiality. Further, just as materiality is inherent in action, so is it also inherent in the knowledge constructed in practice. On the whole, as the foregoing has shown, knowing is material.

Additionally, it is recommended that this rich blending of knowing, practice, and materiality merits a broader probe in our investigations of safety knowledge in organizations. Despite the fact that material objects along with spaces are already a section of the organizational knowing in extant literature, they have been somewhat in the background rather than the foreground. The only difference being the crucial research regarding boundary objects (Bechky, 2003a,b; Carlile 2002, 2004; Star and Griesemer, 1989); other than these and prior to Orlikowski's (2006) work, there is scant theorizing in regards to the role of materiality within knowing. Establishing this kind of material perspective on safety knowing could generate useful ideas for the understanding of safety knowledge transfer in organizations.

SYSTEMS THINKING

Systems thinking serve as a conceptual perspective for thought process that searches to assimilate diverse views in scientific disciplines. This can be different from the actual conventional methodical approach to thought process, which attempts to fragment or take apart on the system into categories so as to analyze the way the several components operate. Bertalanffy (1968) commonly acknowledged as the father of the General Systems Theory, described it thus: "It is necessary to study not only part and processes in isolation, but also to solve the decisive problems found in the organization and order unifying them, resulting from dynamic interaction of parts, and making the behavior of parts different when studied in isolation or within the whole" (Bertalanffy, 1968, p. 31).

In recent decades, the concept *"systems"* continues to be used by practically all scientific disciplines and systems thinking seems to have appeared to refer to the excogitation of problems in their entirety. A system can be described as mental model or even combination of pieces that work together along with one another inside the *system's* limits *(*form*, framework, organization)* to operate*. People *view* their environment more or less as structured into or by systems*. The devices that are around us*, the agencies that create them*, the vegetation that sprout inside the backyard*, the trees and shrubs in the woods*, political *elections,* the households*, the communities as well as ourselves - all could be perceived as systems and *sub-systems.* In systems thinking*, the term system is employed to describe an element as well as the relationships between and amongst its components and also the whole. The systems perspective of the universe holds that the world is all about a systemic hierarchy of integrated sophistication - a sequence of *wholes* inside wholes, just about all of which are

interconnected as well as interdependent.

From this standpoint, a specific system can not be correctly grasped without having also to understand its connection to the world of which it is a component. Systems' thinking is *a* subjective approach of engaging with the world through comprehending the interactions between the numerous systems in the environment. In the manner a mechanistic perspective breaks components down to know the operation of a device, the systems thinking perspective endeavours to know the environment by way of regrouping the interactions which can be found between systems. Most people venture onto the world with our individual models for arranging knowledge, and we present these styles to the people around us. When we study these models attentively we may observe that, similar to every language, these are made of components, processes, principles as well as boundaries. The technology of these relationships is systems thinking. According to Rubenstein-Montano et al. (2001, p. 6), ''problem-solving in this way involves pattern finding to enhance understanding of, and responsiveness to, the problem''.

In 1972, Ackoff and Emery, two renowned systems thinkers, suggested the idea of purposeful systems to strengthen the concept that systems arise within the context of particular goals. Holland (1962) had formalized the notion of adaptive systems which represent the basic need for systems to adjust as well as conform to alterations in the system's context to better attain their goals. Shakun (1981) after that suggested the concept of responsive systems to permit the manner systems learn from previous operation to enhance functioning and proficiency.

Lastly, Rubenstein-Montano et al. (2001, p. 6), indicated that: results from systems thinking rely greatly on precisely how a system is defined due to the fact that systems thinking looks at associations between the several components associated with the system. Limitations ought to be established to differentiate what parts of the world are actually covered within the system and also what components are regarded as the environment of the system. The actual environment of the system may impact problem solving due to the fact that it influences the system, however it is not part of the system. Consequently, knowledge transfer inside as well as in between systems should start with a solid definition of the system being referenced, together with its limitations (Parent et al., 2007).

THE INCIDENT REPORT-BASED SAFETY KNOWLEDGE TRANSFER (IRSKT) MODEL

The Incident Report-Based Safety Knowledge Transfer (IRSKT) model proffers a unique systemic as well as universal theoretical account for specifying the parts and steps necessary to get social systems to create, share as well as utilize new knowledge from incident reports.

By employing the all encompassing systems theory perspective to knowledge exchange, we can understand knowledge transfer as connected to the actual interactions among, as well as within systems; for example, one can see how the systems are associated with specific processes. The systemic viewpoint permits observing knowledge transfer through the way in which knowledge is transferred (the process), as well as what components enable knowledge exchange to achieve success. The IRSKT model is not opposed to the classic knowledge transfer models which refer to knowledge transfer as being a process, but it also concentrates on the parts and the steps an incident report must take in a social system before knowledge transfer can take place. Figure 1 shows that the model contains an accident or a near-miss as the precursor of knowledge translation. The specific components of incident report based knowledge transfer are explained in the next pages.

Basic components of the incident report knowledge transfer process

The transfer process has four basic components. They consist of: The incident report, the stakeholders (employees, safety inspectors, machine manufacturers, government agencies, professional bodies, and so forth.), the safety knowledge transfer system and the outcomes of the safety transfer system

Incident report input: The incident report inputs brings into the system not only the nature of the accident or near-miss but also problems and concerns about machines, structures and operations; including how prone some locations, certain employees and materials are to incidents. These provide a lot of background and direction towards safety culture in the organization. The particular way these materials and persons are integrated gives the incident or set of incidents a pattern. Thus, the stakeholders must be prepared to respond to the patterns of the incidents.

Stakeholders' input: Besides the incident reports, the stakeholders too, input certain skills, knowledge, and attitudes into the system. For example, the HSE manager must institute an effective procedure on passing the information about the incident to other stakeholders and to develop a sound human relationship with the victim that is based on trust, understanding, and respect. A professional relationship must be established with the victim regardless of the victim's behaviour, attitudes, creeds, race, sex, or socioeconomic status so that further details about the incident could come to light. Further, safety inspectors must monitor the trend of incidents in organizations and classify type, nature, severity and other information into categories to help them modify or enforce the existing rules. Employees in the organization have the responsibility for being competent in the use of those
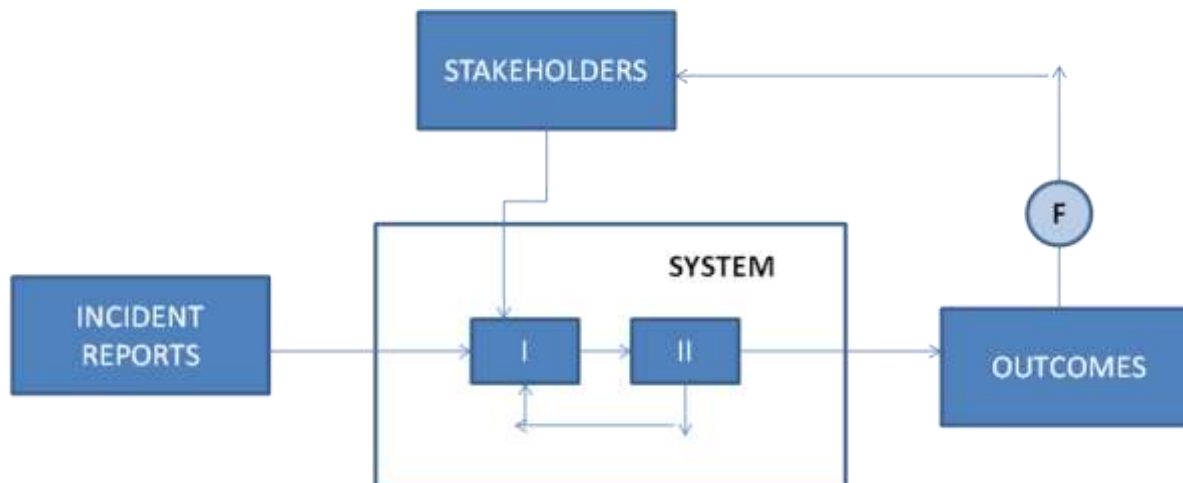
Figure 1. Incident report-based safety knowledge transfer (IRSKT) model.

tools, techniques, and strategies demanded by the safety culture. These include such skills as observation, testing, operation and the use of a variety of other safety techniques.

Safety System: The inputs made by the stake-holders and incident reports interact within the safety system. The type of interaction that takes place depends upon the nature of the safety system used by the organization and the calibre of inputs made into this system by the stakeholders and incident reports.

For example, a particular safety system may not be appropriate for an incident of a certain department or from a particular service. For other incidents, the system may be adequate but the stakeholders may not be able to control or efficiently input their own input sufficiently to enable safety knowledge move from one stage of the transfer to another. The stakeholders may be "turned off" by the frequency or natures of the incidents experienced by an individual or department and thus lose sight of professional responsibilities. A stakeholder may fail to make the type of inputs into the system that would make safety knowledge transfer a facilitative process.

The type of interaction that takes place within a safety knowledge transfer system also depends upon the input into the system made by the incident reports. The report may not be sufficiently detailed enough to facilitate the extraction of safety knowledge into the system. Or, the victim may be deceptive or dishonest in communications with an HSE department. Inputs can be used to the advantage of the organization if the stakeholders utilize a safety knowledge transfer system that has the capability of providing guidelines for working with a wide range of materials and persons, and if the HSE department has the appropriate skills, knowledge, and attitudes to input into the safety knowledge transfer system. It is the primary responsibility of the HSE and not the victim to provide the necessary conditions for effective human interaction.

Safety knowledge outcomes: The last basic component of the safety knowledge transfer from incident report is the output or outcomes of the interaction between the stakeholders and incidents that have taken place within the safety knowledge transfer system used by the organization. Any time incidents happen and the HSE and incident reports engage in the knowledge transfer process there is some kind of outcome as a product of their interaction. This is the "payoff'" of the safety process and the HSE "moment of truth".

The outcomes of safety system can be positive or negative for the organization. For the organization which attains the goals established in the system design, the outcomes represent a rewarding experience. Perhaps the organization has made a decision that will change some machines or structures in the organization. The organization may have obtained information that will help in getting a certain job done safely. Or, perhaps the organization has learned how employees can handle certain procedural situations.

CONCLUSION

Incident reports are used to fulfil many purposes such as feedback for safety programmes in organizations, data for insurance claims, yardstick to assess old safety rules by government agencies, and grounds for creating new ones. Given that an accident and the resulting incident report have the capacity to immediately call attention of stakeholders, including regulating agencies to safety issues, the significance of the report can not be overemphasized. However, there is little research attention focusing on the nature of the knowledge extracted from such reports and how it is transferred within the organization and among the stakeholders.

Therefore, this paper argues for the fusion of systems thinking and materiality of knowledge in understanding safety knowledge transfer (SKT); and to propose a new systems-based safety knowledge transfer model founded on incident reports. As a review of the literature on safety knowledge transfer, materiality of knowledge and systems thinking; it leads to the proposal of a new SKT paradigm. The Incident Report-Based Safety Knowledge Transfer (IRSKT) model identifies the elements necessary for social systems in workplaces to extract, disseminate and use new knowledge emanating from incident reports.

The Incident Report-Based Safety Knowledge Transfer (IRSKT) model proffers a unique systemic as well as universal theoretical account for specifying the parts and steps necessary to get social systems to create, share as well as utilize new knowledge from incident reports.

By employing the all encompassing systems theory perspective to knowledge exchange, we can understand knowledge transfer as connected to the actual interactions among, as well as within systems; for example, one can see how the systems are associated with specific goals as well as processes. The systemic viewpoint permits observing knowledge transfer through the way in which knowledge is transferred (the process), as well as what components enable knowledge exchange to achieve success. Since all systems contain limits, the model considers the area inside which knowledge transfer generally occurs. The IRSKT model is not opposed to the classic knowledge transfer models which refer to knowledge transfer as being a process, but it also concentrates on the parts and the steps an incident report must take in a social system before knowledge transfer can take place.

In summary, we offer a unique safety knowledge transfer paradigm that views safety knowledge as a systemic, emergent, embedded and materially entangled representation of reality. The proposed knowledge transfer model is different from earlier attempts, concentrating movement of safety information in incident reports and the significance stakeholders must attach to them to minimize both human and machine error.

This study shows that the IRSKT model is well suited to analyzing safety knowledge transfer in both complex and small-scale systems. Empirical studies in various systems (of complexity) environments will help affirm and enrich the model. The paper sees that in organizations where safety of employees is important, the ability to extract knowledge from incidents reports – which is an accessible and ready estimate of safety situations in organizations - is vital for establishing safe workplaces. The capacity for effective exchange and utilization of safety information inherent in incident reports by employees, equipment manufacturers, professional bodies and government agencies as reflected in IRSKT will inform the decisions to build in safety in machinery, better safety rules, effective safety campaigns and enhance safety conscious behaviours in organizations.

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