Examining the Relationship between Contribution Behaviours and Knowledge Sharing in Software Development

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Abstract
This paper presents a conceptual model that depicts the relationship between contribution behaviours and knowledge sharing. The research argues that contribution behaviours are essential to knowledge sharing. Due to their high degree of team interaction, agile software development environments may help in examining contribution behaviours and their role in knowledge sharing and in this study are used as a lens to examine the relationship. A qualitative, case study approach was utilised where research findings indicate that in many instances, knowledge sharing cannot occur in absence of contribution behaviours.

Keywords: Knowledge Sharing, Contribution Behaviours, Agile Software Development.

1. Introduction
As a term, ‘contribution’ has many different meanings. In project team environments, contribution typically refers to the role an individual plays in achieving a particular outcome. Individuals, teams, organisations and other entities have very diverse and polymorphous expectations as to what they consider to be a contribution. Olivera, Goodman et al. [19] define contribution behaviours as “voluntary acts of helping others by providing information.” This research investigates the role contribution behaviours play in impacting knowledge sharing within the context of project teams. The paper argues that contribution behaviours are essential to knowledge sharing and that knowledge sharing may not occur in the absence of contribution behaviours. Contribution in the context of sharing information is intrinsically linked to concepts embedded in knowledge management literature because a contribution act associated with coworkers is ultimately any way in which information is shared and communicated with another individual. In the context of IS, a model of contribution behaviours was initially proposed by Olivera, Goodman et al. [19]. In the pages that follow we argue that an intrinsic link exists between contribution behaviours and knowledge sharing to the extent that these behaviours drive knowledge sharing in organisations.

1.1. Research Motivation
Olivera, Goodman et al. [19] outline how contribution behaviours can improve organisational effectiveness and, whilst there is growing research on knowledge sharing, little work has focused on understanding the contribution act in detail. Understanding the role of contribution behaviours in knowledge sharing is imperative in IS for many reasons, one of which is that it “can inform the development of future technologies and practices to improve knowledge
management” [19]. It is well established that knowledge management practices can be a source of competitive advantage and yet while many organisations have invested heavily in knowledge sharing technologies few systems have met their expectations or objectives [19]. From a broad perspective, there is an increased likelihood for innovation, effectiveness and competitive advantage within an organisation if there are high levels of contribution. For these reasons, there is a need to understand the role contribution behaviours play in knowledge sharing. In doing this, organisations can subsequently develop better systems to support and facilitate them. In addition, understanding how contribution behaviours can be facilitated within ISD project teams is imperative in mobilising the sharing of knowledge.

The distinction between data, information and knowledge has long been established. Some distinctions across literature propose that if knowledge is not different to data or information “then there is nothing new or interesting about knowledge management” [9] and knowledge items are not distinctive from what is already known in data or through information. Data is defined as “raw facts that describe the characteristics of an event” [4]; information is when data are “converted into a meaningful and useful context” (such as a best-selling product) [4], and knowledge occurs when the collected pieces of information provide valuable insight that enables decision-making for example, “information about customers becomes knowledge when decision makers determine how to take advantage of the information” [9]. If contribution behaviours surfaces information among team members, then it follows that continuous contributions enable knowledge sharing.

Knowledge in organisations is “rooted in the expertise and experience of its individual members” [7] and can be tacit or explicit in nature. While tacit knowledge is not easily definable because it “involves intangible factors embedded in personal beliefs, experiences and values” [13], explicit knowledge is easily expressed and communicated because it can be “shared in the form of hard data, scientific formulas, codified procedures or universal principles” [12]. An organisation cannot create knowledge by itself; it must “mobilise tacit knowledge created and accumulated at the individual level” [12] by facilitating and promoting the occurrence of contribution behaviours.

This research paper draws on existing literature to construct a conceptual model showing the relationship between specific stages of contribution behaviour (awareness, searching and matching, formulation and delivery [19]) and knowledge sharing.

2. Defining Contribution Behaviour

Olivera, Goodman et al. [19] define contribution as “voluntary acts of helping others by providing information.” In software development contribution behaviours can also relate to employees contributing to team decision making <removed for referring>. Olivera, Goodman et al. [19] explain how “there is a decision-making process about whether, what and how to contribute” which involves “cognitive motivation theories of awareness, searching and matching, formulation and delivery to “explain why individuals decide to allocate time and effort to the contribution act.” Awareness is “a cognitive activity through which a person recognises an opportunity to contribute” and it determines whether an individual “has generated information that is worth sharing, with whom it should be shared and how it should be communicated” [19]. Once an opportunity to share is recognised (either through a direct request for help or proactively seeking to contribute), an individual must then decide whether to act on this opportunity. The motivation and ultimate decision to contribute is in the hands of the employee [1]. The decision to act may also be influenced by the IS facilities available that help maximise the degree of social interaction [19].

Searching and Matching is the next stage of contribution behaviour. It is the stage where an individual determines “whether and how the knowledge domain of the help request matches their own personal knowledge” [19]. Here an individual uses personal or individual knowledge (a combination of explicit and tacit knowledge to help address the request. It is primarily through searching and matching that the potential for knowledge sharing is at its highest as knowledge sharing often “involves identifying matches between personal knowledge and the situations described by those who request help” [19]. Technology that
provides efficient searching and indexing capability will assist in the searching and matching process. This is particularly true if the individual is seeking additional explicit knowledge in their quest to address the request for help. As Griffith, Sawyer et al. [11] explain, “individuals are the most effective media for acquiring and storing tacit knowledge; technology, best for explicit knowledge; while structures and routines are most effective for transferring knowledge.”

Formulation and Delivery is the final stage described by Olivera, Goodman et al. [19] as “a cognitive and behavioral activity through which a contribution is articulated and communicated.” The formulation aspect derives exactly what it is that needs to be delivered or communicated while delivery involves the means by which information or knowledge is transferred or shared. Delivery can take place through multiple mediators such as “oral communications, e-mail or posting to a discussion forum or corporate database” [19]. This stage conveys strong associations with the concept of externalisation whereby a certain amount of individual knowledge may be translated into a wholly explicit form. The availability and suitability of technologies to support the individual in formulating and delivering a response (particularly in distributed environments) increase the likelihood of the contribution occurring [19].

2.1. Contribution Behaviours and Knowledge Sharing

The primary object of knowledge sharing research and practices is to facilitate effective knowledge flow among organisational members [6]. Knowledge sharing is the fundamental basis for creating collective knowledge in intra-organisational networks [6]. This paper argues that an intrinsic link exists between contribution behaviours and knowledge sharing to the extent that these behaviours drive knowledge sharing. Contribution behaviours can be considered as ‘out-of-the-role’ help or ‘extra-role behavior’ which has been defined as “activity that is beyond the prescribed requirements of one’s job or role” [2]. This ‘feeds’ directly into knowledge sharing which implies a conscious act by an individual to participate in a knowledge exchange even though there is no compulsion to do so [14].

A frequent concern for organisations is how to effectively bring people together so that expertise can be shared. There is an assumption that if organisations are successful in creating an environment for knowledge networks and if they can provide the technology to support such networks then it will naturally emerge [18]. Creating a technical solution to support knowledge sharing and best practices therefore is often the first attempt in developing a knowledge-based firm [18]. It is often the primary mediator for sharing and communicating information and therefore has “an important role in effectuating the knowledge-based view of the firm” [1]. However, the incentives for and barriers to sharing knowledge are not really technical [18] and while technology’s role cannot be underestimated, it is but one facet of knowledge sharing. This paper proposes that in order for knowledge sharing to emerge, contribution behaviours must initially occur. Whilst effective knowledge management systems and networks are important for maximising opportunities to contribute within and across teams in organisations, it is equally important to recognise that “technology by itself is not knowledge management” [4]. There is an increasing danger that organisations hide the concept of knowledge sharing behind the systems that support it where excessive emphasis on the technology “shifts the focus of knowledge and knowledge work away from individuals – without whom knowledge can be neither generated, transmitted, nor used” [9].

By focusing our attention on contribution behaviours as an underlying driver for knowledge sharing we can gain better understanding of how we can (and should) promote and facilitate contribution behaviours within organisations and among project teams. Ichijo and Nonaka [12] explain that “sharing knowledge in an organisation or a network is a trigger and a first step of knowledge creation.” Likewise, contribution behaviours are a trigger and a first step in sharing knowledge. Figure 1 depicts the conceptual model which combines primary elements of knowledge sharing research (by Ipe [14]) and contribution behaviour research (by Olivera, Goodman et al. [19]).
The top half of the model is based on research by Ipe [14] which proposes that the nature of knowledge, opportunity to share and motivation to share are interrelated and create an ideal environment for knowledge sharing between individuals. The bottom half of the model shows the three stages of contribution behaviour proposed by Olivera, Goodman et al. [19]. This model indicates that an intrinsic relationship exists between contribution behaviours and knowledge sharing. We propose that individuals engage in contribution behaviours by sharing information and when such contributions have been initiated, knowledge sharing can occur. Therefore, contribution behaviours may drive knowledge sharing. To the left of the model, the information-to-knowledge slider indicates that as individuals engage in contribution behaviours, pools of contributions (consisting of information) are combined which results in knowledge being shared.

3. Contribution Behaviours in Software Development

Research highlights a “growing recognition that ISD is a knowledge-intensive process that requires the integration of specialised stakeholder knowledge” [20]. Patnayakuni, Rai et al. [20] express an ever-growing theme emerging in ISD projects whereby “IS units in similar organisations, with similar skill sets, comparable practices, capability maturity (CMM) levels, and software development tools seem to have markedly different abilities to develop systems.” There are many individual and specific organisational factors influencing this trend however, “a central challenge is that of integrating specialised knowledge necessary to develop the system that is dispersed across stakeholders with business and technical domain knowledge” [20]. Therefore, creating an environment in ISD that promotes contribution behaviours that results in knowledge sharing is imperative in enabling the successful development of systems.

Due to the complex nature ISD, the move to team-based work is something that IS organisations and researchers are long familiar with [15]. In ISD “the tacit nature of user
requirements, project design specifications and overall project understanding cannot be fully captured in formal documents” [16], so project team members must expose information and share knowledge. Teams are capable of creating “synergistic knowledge” which is developed through their interaction [11]. For example, if two team members each know different ways of solving a problem, together they may be able to develop an even better solution [11]. Even greater emphasis is placed on group-driven work in the context of agile software development (ASD), where teams are characterised as self-organising and projects are renowned for their high degree of interaction among team members. As a result, ASD has greater potential and opportunity for contribution behaviours to emerge. ASD methods provide an alternative to traditional software development lifecycle (SDLC). In contrast to the SDLC or ‘waterfall’ model, ASD involves “the integration of various approaches of systems analysis and design for application as deemed appropriate to the problem being solved and the system being developed” [21]. Essentially, agile methods carry out analysis, design, test and implementation stages in short increments placing a strong emphasis on user interaction throughout each phase. There is increasing emphasis placed on personal communication, community, morale, talent, skill and individual competency when it comes to agile methods [8].

Due to their high degree of interaction, ASD project environments are capable of creating greater amounts of “synergistic knowledge” [11]. ASD environments may help in recognising the factors which assist in increasing levels of contribution in a software development context because “agile methods derive much of their agility by relying on the tacit knowledge embodied in the team rather than writing the knowledge down in plans” [5]. Therefore, ASD teams are suitable for providing a lens to examine contribution behaviours and their role in knowledge sharing.

4. Research Method

The purpose of this study is to examine the relationship between contribution behaviours and knowledge sharing. Over the last decade or so, both IS academics and practitioners “have begun to realise it is more appropriate to extend the focus of study to include behavioural and organisational considerations” in order to “improve the effectiveness of IS implementations in organisations and to assess that impact on individuals or organisations” [10, 17]. These are relevant considerations for this study. Given a lack of prior research on the relationship between contribution behaviours and knowledge sharing, a qualitative case study research approach was chosen. The unit of analysis was the ASD team because the level of inquiry as it relates to contribution behaviours and knowledge sharing is at a team level.

The research involved two case studies across two organisations. InvestCo Ltd. is a leading multi-national provider of security software solutions while SoftCo Ltd. is a leading multi-national provider of financial service solutions. In total, ten one-to-one, hour-long interviews were conducted over a three-month period. Five interviews were held with SoftCo team members, whose goal was to develop, test and integrate new functionality. Five team member interviews were also held in InvestCo Ltd. This team was responsible for system maintenance and handling of software release updates.

The units of analysis of a study are often the units of observation, whereby we examine them and often create summary descriptions of such units to explain differences between them [3]. A total of six observations of team meetings were conducted. These are denoted as Obs. C1, Obs. C2 where C1 and C2 represent the cases studied. Each observation was documented and provided valuable insight into the relationship between contribution behaviours and knowledge sharing.
Table 1. Research Participants

<table>
<thead>
<tr>
<th>Code</th>
<th>Role</th>
<th>ASD Experience (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>Developer</td>
<td>2</td>
</tr>
<tr>
<td>SM1</td>
<td>Scrum Master</td>
<td>3.5</td>
</tr>
<tr>
<td>QA1</td>
<td>Quality Assurance</td>
<td>1.6</td>
</tr>
<tr>
<td>SD1</td>
<td>Senior Developer</td>
<td>2</td>
</tr>
<tr>
<td>PO</td>
<td>Product Owner</td>
<td>2</td>
</tr>
<tr>
<td>SD2</td>
<td>Senior Developer</td>
<td>2.5</td>
</tr>
<tr>
<td>SM2</td>
<td>Scrum Master</td>
<td>3</td>
</tr>
<tr>
<td>D2</td>
<td>Developer</td>
<td>1.5</td>
</tr>
<tr>
<td>D3</td>
<td>Developer</td>
<td>0.6</td>
</tr>
<tr>
<td>QA2</td>
<td>QA Lead</td>
<td>0.5</td>
</tr>
</tbody>
</table>

All interviews were recorded, transcribed, analysed and coded using NVivo. Both organisations provided access to documentation relating to project plans and meeting protocols all of which were also analysed using NVivo. As depicted in Table 1, the study involved a diverse mix of research participants.

5. Findings

The findings of this study show a strong relationship between the stages of contribution behaviour and knowledge sharing. In particular, the stage of awareness links directly to that of opportunity to share and motivation to share shown in the conceptual model (Figure 1). As explained by SM1, “some team members aren’t as vocal as others and generally don’t contribute unless they are asked to do so” while D3 explained, “because I’m new to the team, I don’t contribute information as much as others.” SD1 explained how “in agile you have more than enough opportunities to share information with your team. We have dedicated team meetings every day that allow for this and we’re constantly interacting on the floor” while D3 stated; “if individuals don’t contribute it’s really down to them and not the project environment.” This shows that while motivation and opportunity to share may exist, particularly in ASD environments, sharing may not occur if team members don’t act on awareness.

In addition, PO stated that “when we’re in the middle of really complex development and trying to get a piece of working software out the door quickly, everybody has to pitch in” while QA2 explained that under such circumstances “it is vital to share the information we have so that we can generate viable and often really unique solutions quickly.” This highlights that under periods of time pressure, team members are most likely to be motivated to share information and by doing so, they search and match for information across the team, sharing knowledge to inform the solution. This was observed frequently during meetings within SoftCo where the team was under pressure to deliver to their client. The findings show an inherent relationship between the contribution behaviour stage of searching and matching to that of knowledge sharing. Furthermore, findings confirm an information-to-knowledge progression (Figure 1) in that once individual contributions are combined (to constitute collective contribution behaviours) they result in knowledge sharing. For example, SD1 explained, “certainly during complex development, two heads are better than one. When we combine pieces of information across the team and even with other teams we get much ‘cleaner’ solutions” which SM1 described as, “an intensive process when it happens but definitely one where information turns into something invaluable.” This shows a potential to convert information to knowledge via cross-team collaboration where teams engage in contribution behaviours with each other.

Formulation and delivery was evident during two team meetings in InvestCo (Obs. C1) where team members D1 and SD1 shared information relating to very specialised areas of coding (e.g. Linux kernel module). Their formulation and delivery resulted in other members sharing their knowledge of similar complex coding modules. In this instance, formulation and
delivery resulted in knowledge sharing among the team. This observation was supported further when QA1 stated, “sometimes a team member goes into detail about their work explaining everything in a piecemeal manner and this triggers something with someone else who’ll share their ideas.” However in SoftCo, it was found on occasion that formulation and delivery didn’t occur effectively (Obs. C2) and as a result, prevented the sharing of knowledge. D3 explained, “a lot of opportunities to share get missed because I’ve experienced first hand that if somebody isn’t a good communicator then nobody really gets what it is they’re doing so we end up not sharing simply because we didn’t know or understand the problem to begin with.” This indicates that ineffective formulation and delivery can prevent the sharing of knowledge.

### Table 2. Summary of Findings

<table>
<thead>
<tr>
<th>Contribution Behaviours</th>
<th>Relationship to Knowledge Sharing</th>
<th>Primary Implication</th>
</tr>
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<tbody>
<tr>
<td>1. Awareness</td>
<td>Links directly to opportunity to share &amp; motivation to share</td>
<td>While motivation &amp; opportunity may exist, sharing may not occur if team members do not act on awareness.</td>
</tr>
<tr>
<td>2. Searching &amp; Matching</td>
<td>Links strongly to knowledge sharing</td>
<td>Under periods of time pressure, team members are most likely to be motivated to share information; they search and match for information across the team, sharing knowledge to inform solution(s). An information-to-knowledge progression may also occur.</td>
</tr>
<tr>
<td>3. Formulation &amp; Delivery</td>
<td>Impacts knowledge sharing</td>
<td>Effective formulation and delivery may result in other team members sharing their knowledge of similar concepts. Conversely, ineffective formulation and delivery can inhibit the sharing of knowledge.</td>
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### 6. Conclusion

This research presents an intrinsic relationship between contribution behaviours and knowledge sharing to the extent that contribution behaviours drive knowledge sharing. The stages of contribution behaviours consisting of awareness, searching and matching and formulation and delivery show clear links to concepts embedded in knowledge sharing literature including elements such as opportunity and motivation to share. A conceptual model depicting this relationship is presented in this paper. Furthermore, the model proposes that an information-to-knowledge ‘slider’ exists between contribution behaviours and knowledge sharing respectively, so that as individuals engage in contribution behaviours, pools of contributions (consisting of information) are combined which results in knowledge being shared. Some of the research findings have indicated that contribution behaviours are a driver of knowledge sharing and knowledge sharing cannot occur in the absence of contribution behaviours. For example, ineffective formulation and delivery can inhibit knowledge sharing and while motivation and opportunity to share may exist, this will not occur if individuals fail to act on awareness. While this research was conducted in ASD environments to serve as a lens for investigating the research phenomena, further research is needed to determine the generalisability of these findings. Future research could examine this relationship within traditional ISD project teams and draw comparisons to that of ASD teams, which may help in informing the facilitation of contribution behaviours for the purpose of knowledge sharing.

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