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A KNOWLEDGE MANAGEMENT FRAMEWORK FOR SUSTAINABLE DEVELOPMENT: A CASE OF NATURAL RESOURCE MANAGEMENT POLICY WORK IN INDONESIA

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Abstract

The development and implementation of government policy, which we term 'policy work', is a complex challenge that needs to address cooperation and collaboration between multiple agencies and coordination of activities occurring at multiple levels within agencies, stakeholder organisations and the community. This paper describes an action-oriented Task-based Knowledge Management (KM) framework aimed specifically at building capability for policy work in order to address the challenges of a complex policy environment.

Our research is conducted in the context of current capacity-building initiatives in Indonesia focused on the dual policy challenges of sustainable development and natural resource management. In this context our KM approach supports the consolidation of diverse information streams including formal (science) and informal (tradition, social norms, local lore), and provides the means to build a shared understanding of problems (natural resource management) and innovative solutions to those problems (sustainable management practices) involving all stakeholders.

Keywords: Task-based knowledge management, knowledge work, policy work, collaboration, sustainable development

1 INTRODUCTION

The development and implementation of government policy, which we term 'policy work', is a complex challenge that needs to address cooperation and collaboration between multiple agencies and coordination of activities occurring at multiple levels within agencies, stakeholder organisations and the community. In this paper we argue that a practice-based approach to KM provides an infrastructure for the development of capabilities necessary to conduct policy work as a dynamic, collaborative process within a complex environment involving conflicting interests. In particular we demonstrate the viability of this approach beyond its usual organisational scope to broad societal problems at a national level. This is particularly the case with policy work relating to sustainable development and natural resource management (NRM).

We illustrate our approach through our capability building interventions in Indonesia. In the context of NRM, policy work is informed, but also challenged, by a diversity of issues including factors such as demography, cultural, ethnic and religious diversity, economics, environment, climate and geography. Additionally there are structural factors such as location (capital city versus regional town), organisation (such as central vs. provincial or district agency), authority (including competition between agencies) and the physical infrastructure to support policy work. There are also functional factors that influence understanding of those diverse issues and factors that impact the policy. These include political issues inherent in the special interests of the different groups, communities, organisations and agencies impacted by the policy. This requires an approach to policy work that incorporates local knowledge to ensure that implementation of policy is meaningful. While such issues exist in all countries engaged in such policy work, they become prominent in developing countries where the tensions between NRM and economic are heightened. This is a particularly relevant to Indonesia because of its history, geography and political climate.

Such a complex policy environment presents significant challenges to policy work. In politically and economically sensitive areas, such as NRM, policy work can often be frustrated by poor co-ordination and/or communication among government agencies responsible for different aspects of policy (e.g. Ministry of Environment, Ministry of Finance, Ministry of Forestry) and the pleading of powerful special interest groups.

The approach outlined in this paper is designed as an action-oriented framework aimed specifically to building capability for policy work in order to address the challenges of a complex policy environment. For the framework we adopt a practice-based approach to KM known as task-based knowledge management (TbKM) (Burstein and Linger 2011). The application of the TbKM approach is designed to support policy work by addressing both the structural and functional dimensions of policy-making tasks and by integrating different forms of knowledge, including traditional wisdom, across multiple levels of activity and decision making. This approach addresses the challenges facing developing countries, in particular, in implementing an effective sustainable development agenda. We illustrate the application of the TbKM framework in the specific case of NRM in Indonesia in the context of economic development and the response to climate change.

In presenting this framework we engage broadly with IS and Sustainability, with particular emphasis on collaborative action as pathways to sustainable development. However the majority of the literature in this field deals either with specific climate change initiative or internal organisational activities (for example Cabero and van Immerzeel 2007, Elliot 2011, Hasan and Meloche 2013, Melville 2010, Puri 2007, Watson et al. 2010). On the other hand our approach is directed at the development of capability for national policy work at all levels, including executive government, responsible authorities and the agencies that implement the policy initiative. We hold the strong view that IS, as instantiated in our TbKM approach, is the key to unravelling the complexities involved in policy work and addressing the significant sustainability challenges facing developing nations such as Indonesia.

2 BACKGROUND: INDONESIA'S POLICY CHALLENGE – *"PRO-GROWTH, PRO-JOB, PRO-POOR, PRO-ENVIRONMENT"*

Indonesia is one of the most culturally and biologically diverse nations on Earth. It is comprised of an archipelago of over 17,000 islands encompassing two of the world's most significant biodiversity hot spots[1] and ranks as the second richest country in the world for biological diversity (behind Brazil). It is a rapidly developing nation, aiming to become one of the world's ten largest economies by 2025. Indonesia is also currently the world's third largest greenhouse gas (GHG) emitter, and thus is a significant player in the negotiations towards a global response to climate change.

In a speech given on 28 April 2011 Indonesian President Dr Susilo Bambang Yudhoyono gave a clear statement of Indonesia's commitment to sustainable development, outlining specific goals to grow the Indonesian economy while reducing the country's GHG emissions:

> *We in Indonesia … know that we are poised for higher growth and for an important role as part of the climate solution. Thus, our green economic mantra is called "pro-growth, pro-job, pro-poor, pro-environment" – and of course pro-business. Even though we posted the third highest growth among G20 economies, we have been very mindful of the need for "growth with equity", and for an inclusive and sustainable development. It's a lot of balls to juggle with, but it's a necessary challenge.*
>
> *Indonesia is never shy to push the limits of climate cooperation. And with the support of international business community, I believe Indonesia can implement green economy to achieve 7% economic growth and 26% reduction of greenhouse gas emissions from business as usual scenario in 2020.*
>
> *To achieve those goals, Indonesia is seriously developing forest schemes to reduce greenhouse gases emanating from terrestrial sources; such as from forests and peat-lands.* [2]

This statement reiterates previous commitments made at the 2009 G20 summit, built on the outcomes of the 2007 United Nations Climate Change Conference in Bali and foreshadowed in the Indonesian *National Action Plan Addressing Climate Change* (Ministry of Environment 2007). The commitment to reduce GHG emissions is also stated in a 2009 green paper titled *Economic and Fiscal Policy Strategies for Climate Change Mitigation in Indonesia* (Ministry of Finance 2009), which outlines a target of reducing emissions by at least 26%, compared to business as usual, by the year 2020, with the potential for up to a 41% reduction with international assistance.

Most of current GHG emissions are from land-use change, forest degradation and forest fires, particularly in peat-land areas such as are found in Kalimantan. As such, an integrated approach to forest and land management addressing the issues of deforestation and peat-land degradation can make a significant contribution to Indonesia's emission targets (DNPI 2011).

However, developing and implementing policy to address issues such as deforestation and peat-land degradation is a significant challenge requiring new approaches that may involve innovative solutions that fundamentally transform current social and economic structures. As Dr Susilo Bambang Yudhoyono stated in the same speech as quoted above:

> *We need solutions that will transform the way we live, produce, consume, work, travel and play. We need solutions that will place the environment and climate security at the heart of every public and corporate policy. We need solutions that will make economic growth and technology not the nemesis but the ALLY of our climate stability. And we need solutions that will serve the practical needs to slow, stop and reverse the process of climate change.*

Our research is conducted within this context, as part a series of capacity-building initiatives (AusAID 2011) working with the National Council on Climate Change (DNPI, Indonesia) and key research institutions in Indonesia, in particular the University of Palangka Raya (UNPAR) (Central Kalimantan, Indonesia).

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[1] http://www.conservation.org/where/priority_areas/hotspots/Pages/hotspots_main.aspx
[2] http://www.presidensby.info/index.php/eng/pidato/2011/04/28/1616.html

Our challenge is to build local capacity to support the development of approaches that address the dual and potentially conflicting policy objectives of increasing economic development and reducing GHG emissions. Developing and implementing solutions to the policy challenge requires a coordinated approach across multiple agencies and spanning activity from the individual on-ground at the community level up to the high-level governance and policy-making level of executive government. It also requires the sharing and integration of different forms of information, including local ecological knowledge and traditional wisdom, to provide new ways of understanding as pathways to practical, innovative solutions that can be implemented at the local level.

3 KNOWLEDGE MANAGEMENT IN PRACTICE

Knowledge management, in the broadest sense, is a "trans-disciplinary approach to improving organisational outcomes and learning, through maximising the use of knowledge. It involves the design, implementation and review of social and technological activities and processes to improve the creating, sharing, and applying or using of knowledge" (Standards Australia, 2005). As such, KM is ideally suited to address the policy challenges as outlined above. A KM approach supports the consolidation of diverse information streams including formal (science) and informal (tradition, social norms, local lore), and provides the means to build a shared understanding of problems (natural resource management) and innovative solutions to those problems (sustainable management practices) involving all stakeholders.

As a relatively young discipline, mainstream KM focuses on either individual knowledge or the formal processes at the organisational level (e.g. a government agency) (Davenport and Prusak 1998). Both approaches assume that knowledge is codified as information and that technology is deployed to capture, store and disseminate this information. This form of KM is strongly process oriented and, most importantly, is a process that can be managed, controlled and measured. However, KM also needs to be responsive to social networks in the work place and, of course, the political environment that influences knowledge use (Alvesson 2004). The concern of mainstream KM is the accumulation, capture and management of knowledge as an asset (Lambe 2011). Instead, our approach to KM focuses on the importance of knowledge work (Blackler 1995) that involves participants working together on organisationally defined tasks.

Our approach to KM is based on the recognition that most innovations are generated through the work of groups who share an understanding of their work activities by engaging in collective information sharing (collaboration). This is particularly important in addressing challenges that are intrinsically multi-disciplinary, and involve diverse stakeholders, so that the work of these groups is responsive to the context of the activity (e.g. developing climate change policy) and the objective of the task (e.g. poverty alleviation) in a specific situation (e.g. developing countries like Indonesia). Our approach is therefore focussed on understanding what work is actually done, how that work is done, and who does it. Through this understanding we can identify appropriate technology to both support those activities and to facilitate learning and understanding through the performance of those activities.

The critical issue for organisational growth and innovation is the phenomenon of collaborative knowledge work (Iivari and Linger 1999). Knowledge work is characterised as a collaborative activity that:

- allows the object of work to be defined (the inputs, outputs and performance);
- identifies the body of knowledge that underpins the work (the conceptual models);
- allows explanation both in terms of the item of work and the models (sense-making);
- supports the production of knowledge as one element of the outcome (learning); and
- documents the processes (the models) to be used to perform the activity (application).

In our view, KM is about facilitating knowledge work practices rather than the management of information assets (knowledge). This is particularly important in understanding how best to support practical policy work. Policy-making and implementation in the area of sustainable development, particularly in developing countries like Indonesia, requires a collaborative approach to knowledge management across agencies to address the dual aims of meeting the challenges of climate change

while also addressing poverty alleviation. This requires mutual understanding of the problem so as to identify practical solutions. Our formulation of the task-based knowledge management (TbKM) approach (Burstein and Linger 2011), as discussed below, is based on this view of KM and is designed to enable such a collaborative approach.

3.1 The Task-based Knowledge Management Framework

The task-based knowledge management (TbKM) approach (Burstein and Linger 2011) addresses the practicalities of a particular work task (e.g. land and forest management) driven by a specific objective (e.g. reduced carbon emissions). The framework focuses on pragmatic outputs, (actual work –"doing") and conceptual outcomes (theoretical or conceptual underpinning of that work – "thinking"). TbKM is oriented to task outcomes (e.g. change in management practices consistent with sustainable development) and outputs (e.g. reports, publications, regulations, laws) as important drivers of organisational change leading to practical policy work. In addition, the TbKM approach acknowledges that work tasks occur in a social setting and communication (of information, concepts, alternative positions) between stakeholders is an essential aspect of the task. Task outputs are the information resources that are the subject of communications and information flows.

The TbKM framework (Figure 1) consists of two nested interrelated layers that explicitly document knowledge work relating to *thinking*, *doing*, and *communication*:

- the **Pragmatic** layer which is the actual work that needs to be done in order to produce tangible outputs (e.g. forestry management to reduce carbon emissions);
- the **Conceptual** layer which represents the body of knowledge required to perform the work defined by the task, (e.g. ecology, chemistry, hydrology, sociology applicable to forest management).

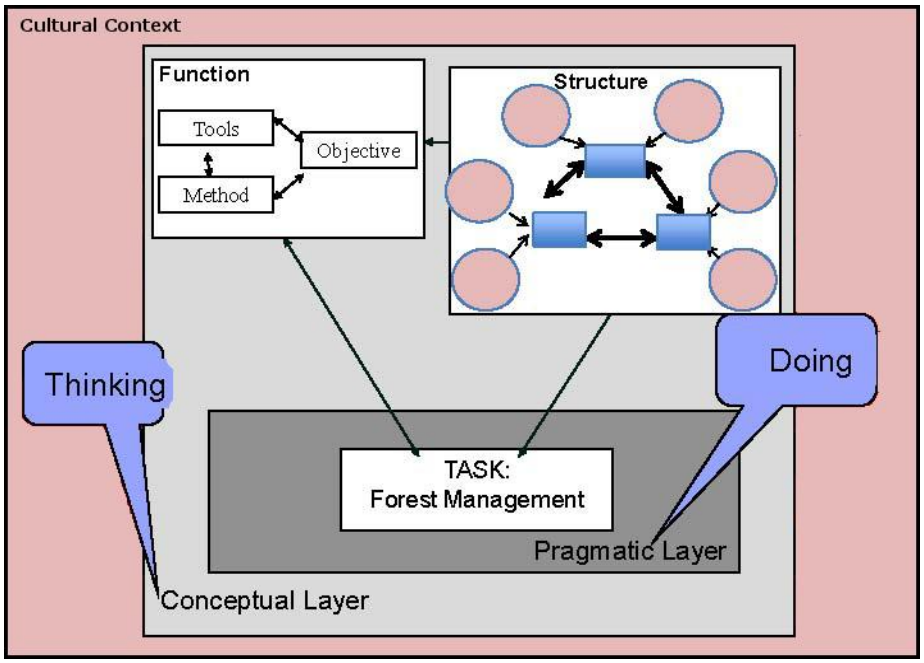

Figure 1. A task-based model of knowledge work (adapted from Burstein and Linger 2011)

Both layers of the TbKM framework represent only those aspects of knowledge that can be articulated and documented: the first as management action, the second as information important in influencing that management action. This is not limited to explicit knowledge, such as published information, but may include implicit knowledge representing what is actually done (e.g. traditional forestry management) rather than what is meant to be done (prescribed procedures), or what is said that was

done (e.g. what is reported). This diversity of information derived as a result of task performance provides a rich resource for policy development, implementation and evaluation.

The focus of the framework is on the conceptual basis of the task, the intellectual work (thinking) that informs the performance of the task (Zuboff, 1988). For example sustainable forest management is defined by the United Nations Food and Agriculture Organization (FAO) as "the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biological diversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological economic and social functions, at local, national and global levels, and that does not cause damage on other ecosystems."[3] Achieving sustainable forest management requires that the economic drivers of timber production be reconciled with the sustainability goal of maintaining biodiversity and reducing carbon emissions, and the social goal of maintaining well-being for forest dependent communities. This conceptualisation of sustainable forest management forms the structural component of the task in the TbKM framework. Figure 2 illustrates the interaction of these 3 drivers of sustainable forest management together with a number of indicative factors that contribute to these drivers. The framework assumes that the tools and methods used in forestry are well established (the pragmatic layer) but that stakeholders need to be equally well supported in their endeavours to conceptualise and articulate (conceptual layer) sustainable practices in forestry.

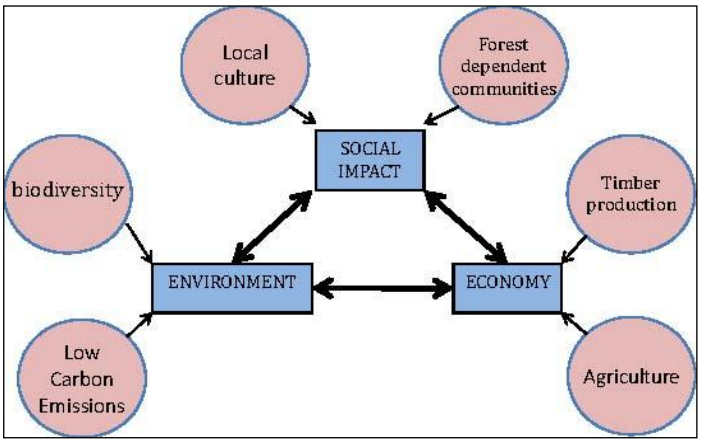

Figure 2. The conceptual structure of sustainable forestry management in the TbKM framework

Implementation of TbKM in an organisational context is focussed on the conceptual layer of TbKM. It is based on an architecture that distinguishes between the **structural** elements that support and facilitate the knowledge processes that are the **functional** elements of KM (Figure 3). This architecture provides the necessary elements to perform gap analyses, determine requirements, and design and implement KM as a socio-technical system. In the next section we describe how TbKM framework was applied to the case of sustainable policy work in Indonesia.

3.1.1 Architecture for Implementing the TbKM Framework: The structural dimension

The structure of KM is the intersection of **organisational design**, **information infrastructure**, and **technology infrastructure** (McDermott 1999; Klein 2007; Butler and Murphy 2007). This is the organisational infrastructure to support storing and transferring knowledge relevant to organisational objectives.

[3] http://www.fao.org/docrep/003/x6896e/x6896e0e.htm (accessed 10 January 2013)

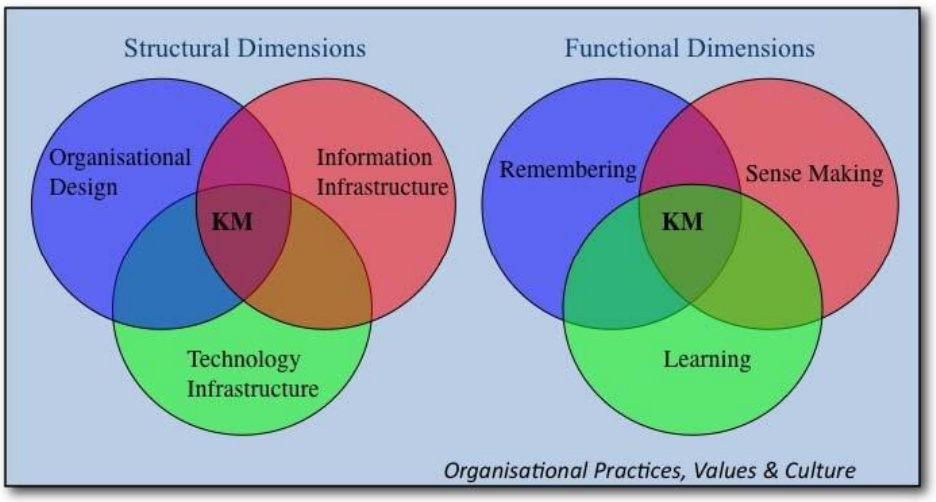

Figure 3. Architecture for Implementing Task-based Knowledge Management

Organisational design includes a broad range of issues that define how KM is organised within a specific task. Important issues include culture (Leidner and Kayworth 2006), governance (Zyngier and Burstein, 2012), reporting and accountability, as well as physical aspects such as location, space allocation (Davenport and Bruce 2002) and staffing (Soliman and Spooner 2000). This is important in addressing natural resource management issues as many different agencies are involved and communication among these agencies (e.g. Ministry of Forestry and Ministry of Environment) is important in developing and applying effective forest management policy (consistent with the aim of reducing carbon emissions in Indonesia while growing the economy to reduce poverty). These are organisational factors that influence how knowledge work is performed in that specific situation.

Information infrastructure focuses on how information is collected, stored, retrieved and disseminated (Davenport et al. 1992). From a KM perspective information includes traditional information repositories such as libraries and archives, but even more importantly, the less formal source of information (e.g. popular media, meeting notes, discussions or traditional lore and other cultural artefacts).

Technology infrastructure is an essential element of KM given the potency of modern information and communication technology. The focus is on the ability of technology to facilitate storing information and most importantly to link stakeholders and information sources and to transfer information effectively between them.

3.1.2 The functional dimension

The functional dimensions include the drivers of knowledge generation: **remembering** (Markus 2001), **sense making** (Latour 1986, Weick 1995), and **learning** (Argyris and Schön 1978; Spender 1996).

Remembering relates to how organisational memory and information repositories are used to support learning and sense making. A key question here is "How does knowledge get used in the organisation?" Similarly, sense making and learning contribute to the development of memory and archival knowledge (Cook and Brown 1999; Brown and Duguid 2001). The key question here concerns how knowledge is processed, for example in developing a simulation model as a means of understanding the dynamics of forest ecosystems. Importantly, how does knowledge influence understanding of policy issues and options consistent with objectives (e.g. sustainable economic development).

Sense making is particularly important in a multidisciplinary context because often there is a need to reconcile conflicting issues. For example, in the case of Indonesia there is the potential conflict

involving economic opportunities from timber harvesting or from the establishment of oil palm plantations versus the need to reduce GHG emissions and to maintain forest dependent communities. Sense making thus often requires incorporating perspectives and techniques from different disciplines e.g. economics and social impact assessment in the example above.

Learning is a creative process that builds on remembering and sense making, deriving new meaning from these processes and re-embedding this understanding into practice. For organisations the focus is on organisational learning, for example individual and collective learning achieved via an organisational culture of continuous improvement (Wang and Ahmed 2003). For natural resource management, learning typically involves reflecting on task performance, assessing the effectiveness of current approaches and developing integrated approaches leading to improvements. This is often facilitated by approaches such as MERI – monitoring, evaluation, reporting and improvement (Commonwealth of Australia 2009) – and adaptive management techniques (Williams 2011).

In TbKM, these elements are closely integrated to the practicalities of task performance: learning to improve how the task is done, understanding (sense making) the role of the task in the specific situation and remembering how the task was done in the past.

The practical implementation of TbKM also needs to take into account the interactions between the structural and functional elements. Thus organisational design, technology and information have an obvious influence on how knowledge is generated and applied through remembering, sense making and learning.

In our case of NRM in Indonesia this is demonstrated in the work involved in current initiatives aimed at reducing GHG emissions targets through trial projects under the banner of global initiatives aimed at "Reducing Emissions from Deforestation and Forest Degradation" in developing countries, better known as "REDD+" (Parker et al 2009). The policy work for development and implementation of REDD+ initiatives involves implementing a specific functional requirement (reduced emissions from deforestation and forest degradation) within a specific structural setting (involving government agencies in collaboration with a range of partner organisations). The functional requirements include the design, monitoring and evaluation of trial programs, which are implemented within the structural context of the relevant organisations utilising local technology and information infrastructure. Thus, for the policy work involved in REDD+ the structural and functional dimensions are inexorably linked. This interaction between the structural and functional elements highlights the dynamic nature of KM and the need to maintain flexibility in order to accommodate change in task performance and evolution of task objectives while at the same time maintaining links to archival knowledge.

4 APPLICATION OF TASK-BASED KNOWLEDGE MANAGEMENT FOR NATURAL RESOURCE MANAGEMENT POLICY WORK

Policy work, consisting of both policy development and implementation, can be conceived as *a process of giving effect to a government strategy*. The first step of application of TbKM requires one to formulate "a task" under consideration. This is not a trivial process (Aarons et al 2005), and depends on the unit of analysis (Linger and Warne 2001). In the Indonesian context, policy work can be considered "a task" as a process applying across three levels of activity (Figure 4):

- the **executive level** where the policy is formulated and defined (e.g. the Indonesian National Council on Climate Change (DNPI));
- the **group level** that includes all stakeholders who will apply and are covered by the policy, usually government agencies and industry sectors (e.g. the Ministries of Forestry, Environment, and Finance); and
- the **individual level** where each stakeholder performs some work that contributes to the implementation of the policy (e.g. Forest managers in a province or district).

Each level deals with knowledge relevant to its activities and this knowledge is filtered up and down to inform the other levels about what the policy work is at that level.

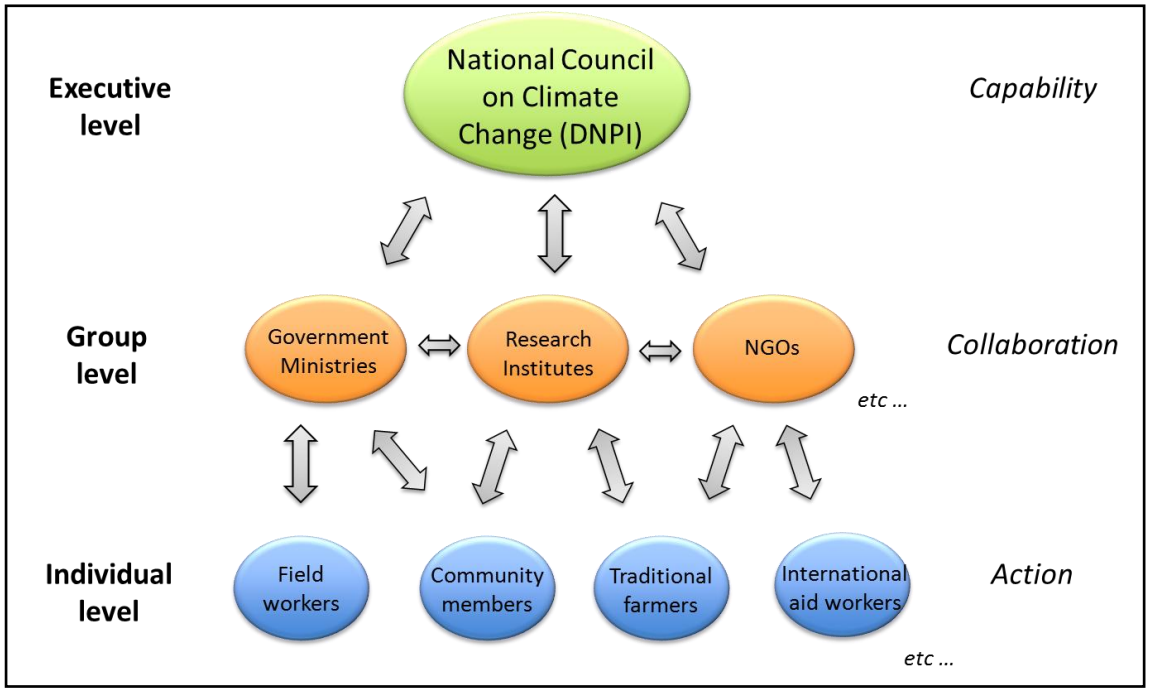

Figure 4. Application of knowledge management across three levels of activity

Policy development defines the tangible objectives that are to be achieved. For example, in Indonesia the approach to addressing GHG emission through REDD+ trials have the clearly defined objective of reduced emissions from deforestation and land degradation.

Policy development also includes an outline of how the objectives will be addressed (e.g. avoided deforestation) and which parties/stakeholders will be involved in the delivery of the objectives (e.g. community forest managers). At the executive (governmental) level, this also means articulating and authorising the capabilities required to implement those policies, not only assigning a budget to the policy but also in identifying the skills, and other human capital factors, required to implement the policy.

Thus at the **executive level** TbKM is focussed on building **capability** and on identifying practical ways of developing and applying policy that is responsive to low-carbon growth strategies.

For example, a broad, multi-disciplinary policy for NRM, linked to REDD+ scheme trials, is assigned to a number of parties (government departments and agencies) and other stakeholders (research institutes, NGOs, local communities). At this group level the collection of stakeholders need to co-ordinate their efforts in order to successfully implement the policy. This collection of stakeholders needs to determine how they work together and how information and knowledge is shared. In this way the stakeholders can develop a shared understanding of how the policy can be implemented practically. The stakeholders need to determine what capability they require to implement their part of the policy and what additional capability is required to effectively co-ordinate their efforts.

Thus at this **group level**, the focus of TbKM is on **collaboration**.

Finally each stakeholder needs to mobilise their resources in order to perform the work assigned to them within the context of the policy. The practical work performed is informed by the overarching organisational goals of each stakeholder (e.g. timber production by the Indonesian Ministry of Forestry). But these activities must be modified to take into account the role assigned to each stakeholder in the collaborative arrangements agreed to by all stakeholders. Similarly, at the individual level, universities such as UNPAR play an important role in developing and applying a

TbKM approach to forest policy by encouraging a multidisciplinary approach, training KM practitioners, mapping capability across relevant agencies, and developing new knowledge through collaborative research programs that include local community participation.

Thus at the **individual level** the focus of TbKM is on **action**.

Traditionally, strategy or policy development and implementation is considered a top-down process. But TBKM combines this with a bottom-up process that integrates action, collaboration and capability in order to reflect how the policy is implemented in practice. This is particularly important when developing and applying sustainable development and natural resource management policy in Indonesia that involves numerous agencies and other stakeholders. The TbKM approach emphasises the need for flexibility at all levels so that practices, structures and objectives can be adjusted so as to reflect what was learnt from the implementation process to date. It also means that information needs to be shared between levels and that the information must flow both top-down and bottom-up.

In our current work, our engagement with DNPI represents a top-down approach while simultaneously we conduct a bottom-up engagement with UNPAR, with a particular focus on gaining a better understanding of community development needs in the local area in Kalimantan.

A specific objective of our interventions is to ensure that the information flow to DNPI is diverse, not restricted simply to reporting against targets, but includes disconfirming and/or contradictory information as well as informal information such as anecdotal stories. The role of TbKM at each level is to support activities that share such information, store it as memory, make sense of it for each task, learn from it and ensure conclusions reached by each stakeholder are taken into account when practices, structures and objectives are being (re)adjusted (e.g. changes to current policy as Indonesia's aspirations to low-carbon growth are realised).

5 TBKM AND KNOWLEDGE MANAGEMENT SYSTEM DESIGN

A central theme of knowledge management is that knowledge must be shared in order to add value to activities that rely on that knowledge. The concept of a knowledge management system (KMS) is therefore grounded in how knowledge is constructed, collected, stored, retrieved and disseminated (Alavi and Leidner 2001).

In general, there are two important conditions that a KMS must meet:

1. the KMS is a socio-technical system that accommodates social activities and integrates them with technologically mediated communications and functions;
2. the KMS is not limited to explicit, coded and documented information but must include informal knowledge and information and not only the written word but also pictures, verbal stories, graphics or any other form.

To develop a KMS means to build a shared resource that is available to all stakeholders, develop practices that share that resource effectively, and develop a culture of trust that encourages interaction between stakeholders. In the context of policy work, such a resource must be available at all three levels of activity. It must be an open resource with little or no restrictions on access and contributions, and must contain sufficient data, information and knowledge so as to be useful in supporting the various activities undertaken to develop, implement and evaluate the policy. An important condition is that the resource (KMS), while always remaining useful, is never considered to be complete nor comprehensive. Policy work processes and activities, at all levels, need to continuously contribute and build the resource while at the same time using it as a memory and as the basis learning from, and making sense of, the activities.

A KMS, as a socio-technical system, is manifestly different to more traditional information systems where information flows are highly controlled and are based on codified information. Computer-based information systems are predominantly focused on automating and/or supporting the functional processes prescribed by the organisation. A KMS on the other hand focuses on allowing participants to explore the informational resources in order to learn and adjust the processes so that the activity can more effectively address goals set for the task and the social practices in which the task is embedded.

This is particularly important in Indonesia where the policy setting is clearly influenced by balancing the needs of alleviating poverty (through economic growth) and addressing environmental degradation (by improved forest and land management). A KMS based on the TbKM approach integrates both the exploratory aspect of the task, the thinking work based on the conceptual layer of TbKM, and the task functionality, the doing work based on the pragmatic layer of TbKM. Moreover the social interactions around the use of the KMS represent the communication work that is integral to TbKM.

Constructing a KMS as a socio-technical system involves both building the technological infrastructure and resource, and developing the capability that will allow stakeholders to effectively use this infrastructure. While the technology usually already exists, it usually needs to be adapted and extended to incorporate a different set of functionalities. Developing capability to exploit this resource requires education, training, mentoring and practical problem-based learning. People need to understand knowledge management principles so they can address the conceptual (explore their situations/context of their activities), managerial (decisions and judgements) and practical (work practices) aspects of their tasks so that they can use of the KMS effectively and exploit the potential of the information and knowledge resources. In Central Kalimantan, our interventions involved these capability building activities but we did not have access to sophisticated technology infrastructure and needed to improvise to support our activity. Our experience highlight that in developing countries the technology infrastructure cannot be taken as a given.

Of paramount importance is to develop the capacity to work collaboratively with diverse partners and in different contexts, as well as participate appropriately at the three levels of activity. Indonesia government policy in the area of natural resource management is inherently complex, multi-dimensional, long-term and requires a multi-disciplinary approach as it does in other countries. This means that there is a need for a much broader range of stakeholders to be involved in the development and application of the policy and many of these stakeholders would not have previous experience of working together.

In turn, this places more emphasis on the need to collaborate and to facilitate knowledge exchange and information flows across the network of stakeholders. It is important therefore that the KMS does reflect the characteristics of a network, with each stakeholder able to communicate directly with any other stakeholder, rather than any externally imposed command and control hierarchy. Such an approach to the design of the KMS facilitates the development of trust relationships between stakeholders and this in turn ensure more open and comprehensive knowledge exchange and effective information flows. This approach is more likely to yield practical, cost effective, and consensual approaches to sustainable development and natural resource management policy development and application in Indonesia.

To date we have applied the KMS architecture to inform the development of capacity building programs. Our current work involves training stakeholders in TbKM principles and facilitating collaborative research in Central Kalimantan. The focus of our work is on addressing key knowledge gaps, particularly those that relate to policy priorities, and on strengthening the links between research and policy by addressing barriers to knowledge uptake in policy.

6 CONCLUSION

The TbKM approach presented in this paper represents an interpretation of KM that is practice-based so can be readily integrated into work activities. The architecture for implementing TbKM (Figure 3) provides the design criteria for a socio-technical KMS to implement TbKM by identifying the structural and functional aspects of the KMS. It is particularly applicable to the complex, multi-dimensional problem of natural resource management, particularly in developing countries, because it can be applied at the three levels that address the policy imperatives of capability, collaboration and action.

The contribution of this paper is to demonstrate the application of this framework outside the boundaries of a single organisation to a societal problem, sustainable development, at a national level. In the case presented in this paper, the KMS architecture is applied to support the consolidation of diverse information streams, including formal (e.g. science) and informal (tradition, social norms, local lore), to provide the means to build a shared understanding of problems (NRM) and innovative solutions to those problems (sustainable management practices) involving all stakeholders. Bringing together different forms of knowledge in this way can also provide a pathway to innovative policy solutions, for example alternative approaches to unsustainable economic development.

Specifically we demonstrate the viability of applying the TbKM approach to address the challenges of policy work in the context of sustainable development and the response to climate change in developing countries such as Indonesia. In the context of this national policy work, the impact of the TbKM approach lies in its ability to address all levels of activities and its focus on building capability, enhancing collaboration between diverse stakeholder and supporting activities in the field that execute the policy plans. Significantly TbKM does not only support such activities but also integrates them to provide a rich, comprehensive and realistic understanding of policy development and implementation and a resource for evaluating that policy. However, we recognise that the effectiveness of using the TbKM approach as a tool for policy work is dependent on a range of other factors, such as, for example: adequate resourcing, political support and consistency of application. As with any other tool, its successful application depends on it being utilised in the appropriate manner.

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