

# A MODULAR APPROACH FOR STIMULATING KNOWLEDGE USE IN ORGANIZATIONS TO ATTAIN REAL SUSTAINABLE INNOVATIONS

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## **Abstract**

The Fociss (Focussing Innovation for a Sustainable Strategy) approach is a structured method to define core business related issues within sustainable development that require main attention in a specific company. In theory, Fociss has the ability for all kinds of innovations, but the implementation of radical sustainable innovations is often lagging because of complexity.

Such innovation problems have often been discussed in the literature of (Knowledge) Management Studies. The 'ambidextrous' organization provides a solutions to develop a repository of challenging, disruptive innovations. A communities-of-practice (COP) is such a solution which is based on the competences and ownership of workers, motivating them to apply their creativity and support the subsequent implementation.

A Fociss scan, performed by students of Avans Hogeschool at IHC Merwede resulted in incremental innovations at which the company was already working and radical sustainable innovations, which were not further developed. However, at the same time knowledge workers were active with different sustainable innovations around 'greening' materials while using virtual communities.

We suggest to depend the initiation and further application of Fociss of the presence of work floor communities. If virtual communities are present, management may invite them to apply Fociss for their own account. This increases the repository of a variety of sustainable innovative ideas that the company can implement directly or when the situation asks for it so that it will strengthen the company's future basis. This integration results in a synthesis by which we can instruct companies and students to attain success in their future 'sustainable business management'.

## **Keywords**

*sustainability, innovations, modularity, competences, knowledge.*

## **1. Introduction**

During recent decades, innovation studies have researched the development of new ideas via various angles. Firstly, there are different types of innovation (product and process innovation), secondly researchers have studied the scope of the innovation (incremental and radical innovation, meaning within or beyond the dominant design) and thirdly the nature of innovation (sustaining vs. disruptive, meaning accepting or changing the nature of the business) has been under scrutiny (Anderson & Tushman, 1990; Christensen, 1997).

We use these angles in a study towards the application of the Fociss method (Focussing Innovation for a Sustainable Strategy) for delivering sustainable innovations (Venselaar, 2010ab). Fociss uses a top-down approach that is aimed at offering sustainable initiatives from a long-term, systematic perspective. Top-down means setting clear goals based on an understanding of the place and role of a company in sustainable developments and transitions which take place.

Sustainable innovations require also bottom-up approaches in companies. Bottom-up means that the knowledge and creativity, which is available in a company to find and develop effective innovations, must be 'made free' and mobilized. The discipline of Management Studies offers a bottom-up approach that defines a modular set of competencies that, consequently, draw the architecture for coordination between the knowledge workers (Breukel et al., 2009). This business model, rooted in the company's mission, offers the workers the playing field for effective knowledge transfer so that they can 'autonomously' develop innovations based on their intrinsic values.

The goal of this paper is to integrate top-down, goal-oriented frameworks with bottom-up knowledge management in order to attain the best use of the knowledge of people in organizations so that:

- all types of innovations may be possible (product and process);
- opportunities are developed for incremental and radical innovations;
- innovation results in the creation of new kinds of value (sustaining and disruptive) to enable new market growth (Gilbert & Bower, 2002).

Therefore, we explore options that integrate top-down and bottom-up approaches that enrich both sustainability and knowledge management disciplines. Moreover, this integration results in a synthesis by which we can instruct companies and students to attain success in their future 'sustainable business management'.

Firstly, in the theoretical part we introduce the structure and impact of Fociss, and explain that sustainable initiatives in companies do not always 'take off' because they do not become part of the firm's 'knowledge infrastructure'. We compare with this problem with innovation issues in the field of Management Studies. This comparison offers some interesting insights to supply Fociss with a more autonomous knowledge management. As a result, we develop a proposition about a more effective method for sustainability innovations. Secondly, we describe the method of study, which is an explorative approach. Students participating in the minor Sustainable-Technical Innovation Management at Avans Hogeschool have gathered data at IHC Merwede, a ship building company that offers design and construction activities for the specialist maritime sector. The students have applied a Fociss scan and a knowledge management scan separately. Consequently, the authors have conducted interviews at IHC about the results of the students. Thirdly, the results section presents the data and comes up with an exploratory model in which Fociss takes specific elements of knowledge management into account in order to have different start-up trajectories at its disposal, depending on the knowledge management situation of those companies. Finally, we draw conclusions about the possibilities and advantages to integrate goal-oriented and autonomous approaches in the field of sustainable innovation and finish with suggestions for further research.

## **2. Theory**

### **2.1 Fociss: intended innovations in line with existing goals**

The Fociss approach is a structured method to define the core business related issues within sustainable development that require main attention in a specific company. It creates a future aimed, middle and long term, focus for innovation, for critical factors that require attention and for the business model that has to be adopted to continue being profitable and socially acceptable. That can be characterized as 'Intended Strategy'.

Fociss uses the order sustainability before innovation, meaning that innovation that does not take the (near) future constraints set by sustainable development into account will not pay off

in the end. Often sustainability is only brought in as the second step, intending to make the already selected innovation as sustainable as possible. It should, however, be the other way around. As example: some companies invest heavily in renewable energy and new innovative low energy processes because that is seen as the present most urgent priority to become a sustainable business. However, when the company does not produce products which contribute sufficiently to what a sustainable economy as a whole needs addressing issues such as uncertainty of resources (copper, wood), socio-economic problems with resources (bio fuels, child labor) or unpleasant effects of their products (obesity, problematic wastes) they might have set the wrong priorities to stay viable on the long run.

Fociss narrows down on company specific issues through a stepwise assessment of regional and global trends, influences on the sector as a whole and finally the effects in the particular economic, social and physical environment a company operates. Therefore companies must also be aware of the system level on which transitions take place and on which their response is the most effective. Three levels can be distinguished: the production sector itself, the production chain and society as a whole as shown in Figure 1.

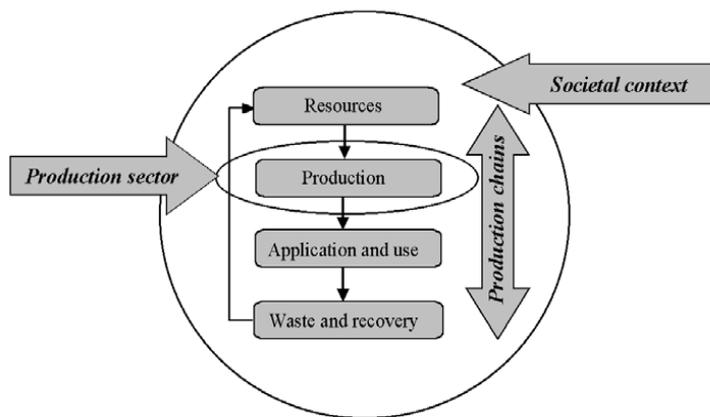


Figure 1: Three levels of systems and transitions

The result is general insight in the sustainability issues that really count for the company, a set of possible innovations and focal points for innovation and a view on priorities for the near and middle term future.

The method has been developed on base of the observation that actually all companies accept sustainable development as a major driving force for new developments in businesses. However most companies, in particular smaller ones, find it difficult to translate

this insight into concrete actions. It proves to be difficult to evaluate how sustainability can affect a business. Too many aspects and issues are involved and priorities are not clear either. For really effective sustainable business strategy a company must concentrate on a limited number of key areas and issues which constitute a company's major challenge for sustainability and continuity and are specific for its own character, products, location and ambitions. Small and mediums sized enterprises (SMEs) in particular do need a straightforward, short and simple approach to help them.

The FOCISS approach offers that. It is the outcome of practice based research in cooperation with industries from different sectors. It differs from other approaches by setting the 'agenda' for sustainable business in clear relation with the core business and core competences. It involves interviews and workshops involving company staff from all departments (see Table 1).

Table 1: Outline of the FOCISS protocol

	phase of study	focussing on
1	Preparatory	introduction in company
		selecting participants from staff and management
2	Scope	coherent set of products/services with comparable production chain
		collecting background information
3	System oriented	identifying the role of company in economy and society, for the specific products and services
		levels involved
		system / level specific issues and developments
4	Sector oriented	main specific issues in the industry sector
5	Key areas of attention	information and views available at the staff, and if possible other stakeholders

Because of that it improves exchange of views and information on such issues through all departments, leading to real commitment, ambitions and an understanding of what sustainability really involves (Venselaar 2010a, 2010b).

## **2.2 Assessment of the effectiveness of Fociss**

Critical key issues of Fociss describe potential innovations. They can be divided into three groups: 'expected', 'to some extent unexpected' and 'complete surprises'. Other studies have shown the following (Venselaar 2010a, 2010b).

1. The expected and obvious areas and issues are those which are very recognizable and fashionable and are often already being dealt with in a company. They score immediately highly in the interviews.
2. The 'to some extent unexpected' areas and issues typically concern socio-economic developments in the region or 'elsewhere'. They are generally known in the company, but are up till the Fociss scan not seen as crucial, and receive a high score in the discussions.
3. Totally 'unexpected' areas and issues, that no one else is really aware of, are often brought up by just one individual or are suggested by the researchers. Those are the issues that are often 'unique' and originate from the specific processes and activities, or the particular circumstances in which a company has to operate. Understandably the issues and innovations for the 'non obvious key areas' cause the most debate. Proposals to choose priorities in those areas are met with reluctance. Not because one is uncertain about the priority it should receive, but because the obstacles to address them are clearly seen.

In only half of the studies the final step of selecting critical key innovations or starting points for making this selection was reached. Some companies were already quite satisfied with key issues on which further strategy development could take place. In some cases new investments were already planned, so these issues would be pursued 'automatically'.

In most cases, innovations were selected that involved simple alterations addressing specific environmental and social issues. These had not a large impact on other issues or sectors and were confined to the lowest system level i.e. production within a company.

Innovations that require changes in the total product chain (system level two) were selected less often. They concern changes in the way the chain operates, and require 'integrated innovation'.

A last category of innovations concerns the 'revolutionary changes' in the way the company operates, in its products and/or in the way it helps society 'to take care of its needs'. Usually drastic changes are not immediately required, but any future change and innovation will now have to fit in the direction dictated by such a 'third level innovation'. In

some studies such innovations were discussed, but finally not selected, because they were considered being too difficult to implement, on this moment anyway.

An evaluation of the arguments used, showed that actual acceptance and implementation of selected innovations is determined by many factors. Two main factors have a 'system character' and are often decisive. One factor is the system level involved in implementing an innovation, meaning that changes have to occur there and consequently collaboration on that level is needed. At a higher system level, more changes are needed and the influence of a single company is smaller. The other factor is the complexity of the changes in the company, its processes and organizations, which are needed to introduce an innovation (see Figure 2 with an example from the chemistry sector).

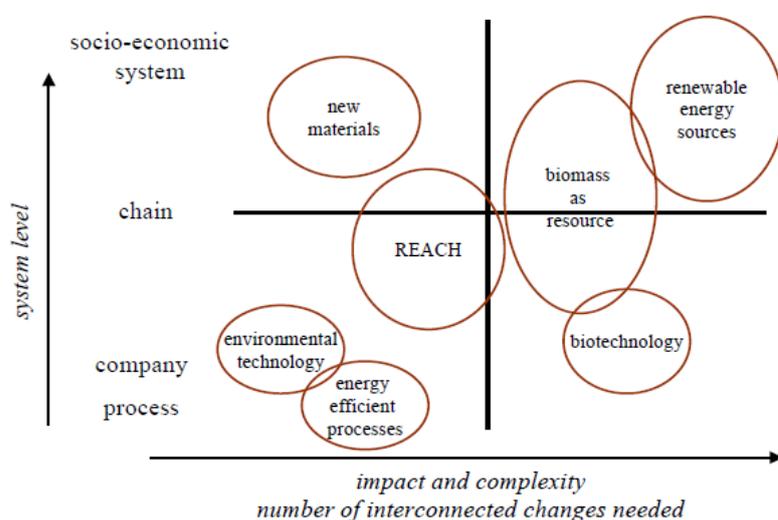


Figure 2: Impact and complexity of issues regarding innovations in chemistry

Adding equipment and procedures or exchanging one for another that is more efficient, is simple. Introducing a complete new process which requires new equipment, new training of operators and new organizational structures in a company is very complex.

### 2.3 Comparison of the development and success of Fociss generated innovations with experiences from innovation literature in the discipline of Management Studies

The described assessment of Fociss follows the analysis from Tushman & O'Reilly (1996), who discuss the success syndrome (see Figure 3). Successful companies have learnt what fine-tuning efforts work well, and have integrated them in their operations, structure and strategy. They use feedback to create a better congruence between all these elements. A

lack of congruence is seen as a cause of problems, so that they solve this lack by incremental steps. The system gets aligned over and over again but is not fundamentally adapted. Change is a part of short-term success, but inhibits transformational change that is needed in the case of environmental shift.

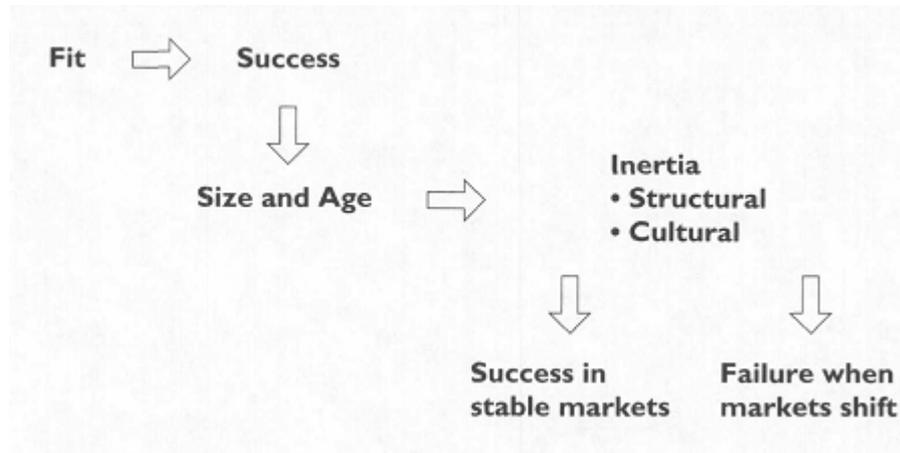


Figure 3: Success syndrome (derived from Tushman & O'Reilly, 1996)

So, although stability creates certainties on the short-term, stable incumbents have potential drawbacks when the environment changes.

Management Studies have paid much attention to this syndrome. The ability of incumbent organizations to deliver major innovations was doubted by writers in the tradition of Organizational Ecology (OE), which oppose the adaptation view of organizations. Hannan and Freeman (1989) distinguish between changes of core changes and peripheral changes (Hannan and Freeman, 1989). Core changes refer to transformation of strategic, structural and technological contents of firms; changes in peripheral elements refer to incremental changes within these organizational forms.

OE claims that sticking to the identity of the core properties is beneficial for organizations because it increases their reliability and accountability in the eye of the customers and so legitimates the organization. OE studies this issue by comparing the mortality rate of unchanged incumbents with changed incumbents, and generally finds higher hazards of changing incumbents. In 1993, Amburgey et al. (1993) focused on the impact of core transformation on the mortality rate of Finish newspaper companies. They found exploding hazard rates when frequency and content of editions were transformed. A major cause of this change problem is that technological changes may render existing competences obsolete. Also Christensen (1997) claimed that incumbent organizations were

not better off than new entrants. On the contrary, new entrants wiped out on-going “disc-drive” organizations during the introduction of advanced disc-drivers that were based on new technologies. New product innovations were detrimental for incumbent; incumbents had been so much tied to expectations of their existing customers that new entrants with new innovations could easily take over.

Also successful changes have been reported in the tradition of OE. Amburgey et al. observed in 1991 that the cumulative increase towards generalism and specialism had mixed but non-significant detrimental and beneficial effects. Burgelman (1991) gives an example of a beneficial transformation when he described the development of Intel’s new microprocessors.

The general opinion in OE, however, is that adaptive efforts have a random survival rate, meaning that managerial efforts do not have a positive impact on firm survival.

But what if the environment demonstrates a dramatic change? The historian Hannah (1997) demonstrated the relatively good performance of adaptors. Although disappearance and decline have been the common fate of the 100 largest industrial firms since 1912, the few survivors have been adaptors. The changed incumbents are relatively more successful than the average new entrant in the population. This is in line with the interpretation of Chandler (1962), who had earlier documented the transformations of organizations towards conglomerates with the very successful multi-divisional form. Obviously, these conglomerates were not born into this form but have developed themselves to it.

Proponents of contingency theory (CT) address the ability of successful organizational change. The change rationale is that exogenous changes in market and technology create disequilibria so that organizational tasks cannot be well performed in the old structure. This problem stimulates management of organizations to find a better administrative design to reach task productivity (Donaldson, 2001). Studies show that organizations need to change their form in order to fit disruptions in the environment (see for instance Huber and Glick, 1993). In this view, transformation is the leap of an individual organization to a new form. Incremental changes have the function of ‘lining’ the business within a certain form. Miller and Friesen (1982) have demonstrated the beneficial impact of transformational (or quantum) changes.

The role of learning may be an important factor in this discussion between OE and CT. This also depends on the complexity of the innovation because it is related with the role of

previous knowledge. Utterback & Suarez (1993) demonstrated that the learning experiences of organizations in periods of ferment supported their survival in periods after the transformation to the dominant design. Tushman and Anderson (1986) had earlier studied the importance of the knowledge needed to conduct changes. Incumbents were better to provide incremental innovations with small knowledge changes but could not always provide innovations that were based on larger changes in knowledge. Where previous knowledge was not important anymore, new entrants have major advantages (competence destroying innovation); where previous knowledge was still important, incumbents have a leading edge (competence enhancing innovation).

James March (1991) also applied a learning perspective and discussed this tradeoff between stable exploitation (refinement, incremental innovations) and dynamic exploration (renewal, radical innovations). He supported the observation that a process of refinement is dangerous for exploration in the long run. As long as the explorative results are uncertain, organizations follow a 'satisficing' course. Refined exploitive efforts are more reliable and create better average performances, although reliability not automatically benefits the competitive position. Burgelman (1991) states how exploitation and alignment with existing business is often leading part of strategic reorientation. The actual core business determines the focus, and this focus only changes when environmental pressures force them.

Loosely, independent learning efforts create more variation for later primacy among competitors but, due to their uncertainty, slow socialization and moderate returns are needed to prevent people to adapt to the prevailing code (March). This involves strategic renewal, and is used to change core business. Here, autonomous initiatives create variation and offer new value by means of disruptive innovations and adaptation, often by means of temporal structures (Christensen, 1997; Gilbert & Bower, 2002). As long as the environment is stable, organizations may store this variation and build a repository, but they need to apply these initiatives when environmental shift occur (Burgelman, 1991).

The paper of March has been a key point in the discussion about the concept of ambidexterity, which refers to the fact that organizations need to exploit/align and explore/adapt simultaneously in order to meet different environmental and technological demands (Gibson & Birkinshaw, 2004). The so-called ambidextrous organization may be a way out of this divide because it has ways to deal with different demands at the same time and is able to function effectively in stable and dynamic periods (Tushman & O'Reilly, 1996).

Gibson & Birkinshaw (2004) provide suggestions to shape an ambidextrous company to 'wed' alignment for coherence and adaptation to meet changes. They distinguish between structural ambidexterity and contextual ambidexterity. Structural ambidexterity refers to organizational mechanisms such as separate units, partitioning within a business unit (creating organic and mechanistic parts) and a temporal separation of groups of people. All these options suffer extra coordination costs. Contextual ambidexterity refers to the option of building sets of processes and systems that enable individuals to make their own decisions, to divide their time between different demands so that adaptation of entire business unit may take place without coordination disadvantages.

This latter may benefit from mechanisms that have been found by Adler et al. (1999), who has studied the introduction of the very successful Toyota Production System (TPS) in the USA. The whole idea was to replace the traditional sequential product development (downstream interaction) by early reciprocal interaction between design, engineering and manufacturing (joint product/process optimization; front-loaded mutual adaptation) in order to deal with tacit and codified knowledge in an effective way and to reduce the number of later adaptations. It included long-term contact with suppliers. She has found comparable mechanisms to deal with efficiency and innovation simultaneously

1. Meta-routines: problem solving routines for continuous improvement, documentation over changeover, reflecting review (best practices, hansei).
2. Integration: autonomy in job design (no additional method engineering department, routine kaizen).
3. Switching temporary: temporary assignment in a pilot team (non-routine kaizen in quality circles, volunteers).
4. Partitioning: creating a pilot team to design work processes for the lay-out of production process and to train superiors and workers in new jobs (informal: no prior instruction).

The first two mechanisms align with contextual ambidexterity and the third and four mechanisms refer to structural ambidexterity.

#### **2.4 Emerging innovations: challenging the core business of the organization**

The discussion about ambidexterity exemplifies the necessity for organizations to embrace new radical new suggestions even if they are still focused on the refinement of their existing business. Therefore, we will now turn to bottom-up approaches to support Fociss to deal

with the indolence of the sustainability innovations. The value of bottom-up approaches was put into the words by Konosuke Matsushita, the founder of Panasonic, who was quoted by Labovitz et al. (1993) as follows: "We will win and you will lose, because your firms are built on the Taylor model. Even worse, so are your heads. With your bosses doing the thinking, while the workers wield the screwdrivers, you're convinced deep down that this is the way to run a business. . . We are beyond the Taylor model. Business, we know, is now so complex and difficult, the survival of the firm so hazardous in an environment increasingly unpredictable, competitive and fraught with danger, that its continued existence depends on the mobilization of every ounce of intelligence."

This bottom-up approach starts with the vision of Ciborra (2002), who has explained that controlled planning, process and structural schemes give an unrealistic image of the reality, and that instead all kinds of *bricolage* (re-ordering of people and resources: experimentation, but not random) and *tinkering* (trial-and-errors) takes place based on inspiration, intuition and imagination. An innovative organization renews itself constantly and dares to change former goals, but at the risk of chaotic situations. To prevent chaos, its innovative behavior should be embedded within an organizational framework.

We have developed a scan that looks for appropriate organizational mechanisms (such as temporal and separate business units and meta-routines) so that knowledge workers are encouraged to come forward and develop and introduce their own (sustaining and disruptive) innovations based on their skills and knowledge. In line with Grant (1996), we have applied a modular approach to understand the related skills and competences. Modular systems have been described as (nearly) decomposable subsystems related by architecture, interfaces and standards for the coordination between functional subsystems or modules (Clark & Baldwin, 1997; Langlois, 2002).

Because the organizational mechanisms prevail especially in the field of Knowledge Management, where they support the development, transfer, application and evaluation of knowledge (Weggeman, 2000) and because they are based on modular built competences, we refer to the scan as a modular knowledge management (MKM) scan. This scan has been unfolded elsewhere (Breukel et al., 2009), but the main structure will be presented below.

Firstly, we look at the prevalent core competences that emerge for the workers actions. They are knowledge sets embodied in employee knowledge and skills and organizational systems with an increasing tacit component and guided by managerial systems, values and norm

(Leonard Barton, 1992). They are built up from capabilities, which in turn contain skills and assets (Hafeez et al., 2002). Employees are using their skills, and combine these skills with the present assets, in order to execute an action. The skills themselves are performed at the deepest (base) level. The capabilities, which are strongly related to each other, are categorized into a modular building bloc of competences. Some blocs show strong similarity with the formation of internal activities. We refer to them as functional competences. Other sets are filled with coordinating activities and relate the functional blocs. Together, they make a higher building bloc of at least two functional competences at least one coordination set. However, coordination also takes place within each bloc of functional competences, namely to relate the underlying capabilities.

The competences are rooted in the organizational context and depend on the then present organizational ideology and vision of the organization (Prahalad & Hamel, 1990). The core ideology (values and purpose) of a firm firmly determines the space organizational members may act. This ideology is fixed firmly within the culture of a company (Collins & Porras, 1996). The envisioned future of an organization, however, leaves more options for changing the course of a company. It describes the main goals of the organization, and defines the core business, competences and products. Although these 'big goals' do not change easily, circumstances may force organizations to shift their course. A famous example is the transformation of a chemical manufacturer (Merck) into a drug-making company, which may be seen a major explorative strategic renewal. And knowledge workers may contribute to this change by their releasing their creative capacities.

Secondly, we typify functional knowledge by the difficulty, indicating complexity and variability or the interrelations of their components (Adler, 1995; Perrow, 1970). The complexity and variety of the functional entities within the modules, which indicates if the work is simple, complicated or even chaotic, is a first contingency for the needed coordination of the module (Perrow, 1970; Snowden & Boone, 2007).

Thirdly, we compare the needed coordination with the prevailing coordination. Different means of coordination are mentioned in the literature, on a scale from standardization via routines until improvisation (see Figure 4). The application of this range 'standardization-routines-improvisation' to a modular system results in the notion that deeper in the system more improvisation as coordinative means is used, that on medium level coordinating routines are feasible and on the surface standardization is appropriate.

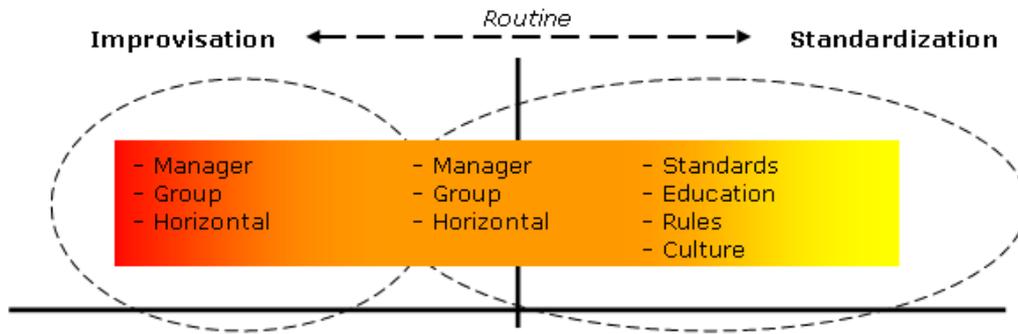


Figure 4: The range of coordination competences

Besides, increasing client demands drive the need for extra technological knowledge requirements. In turn, this raises the dynamism and/or complexity of functional routines and the need for elaborate coordination to achieve effective performance. However, when technology is able to absorb relevant knowledge, it offers the potential for making capabilities more functional, subsequently, routines simpler and eventually standardizing routines. As stated before, these developments do not always have the same temporalities (Langlois, 2002). Therefore, in order to bridge the levels of client demands and technological opportunities, coordination swings back and forth between improvisation and standardization (Ciborra, 2002). These swings may offer new inputs to knowledge (by improvisation), support development and distribution of knowledge (through routines in which members collaborate) and finally contribute to the retention of knowledge (by routines and standardization). Guided by their ideology, each surviving organization creates itself a unique path of innovation by mixing new inputs with historically dependent routines and standardization (Collins & Porras, 1996).

The higher the difficulty of the functional competences within a particular modular unit, the more the needed coordination value shifts from standardization via routines to improvisation. This line of reasoning is the basis for a gap analysis of the present (IST) and required (SOLL) coordination.

Fourthly, the gap analysis between the needed and present coordination results in suggestions to ramp up coordination problems by means of KM techniques, including organizational constructions such as communities-of-practice (COP) or other structural interventions for knowledge creation and circulation (Hildreth et al., 2000; Dyer & Nobeaka, 2000). These KM techniques encourage knowledge workers to innovate from the present

functional competence so that variation, selection and retention of novel ideas is stimulated (Burgelman, 1991).

- Variation: developing emerging ideas within an (semi-)autonomous context. People from different locations are allowed to demonstrate and interact about complex, varying and even erratic ideas to recombine them for innovative solutions.
- Selection: the managerial task consists of a way of hosting (by means of linking and fostering communities) of organizational and network members in order to finally select the most suitable ideas (Wenger & Snyder, 2000).
- Retention: involving knowledge workers with the application of their ideas and support them with metrics. Wenger and Snyder (2000) observe the fact that the pay-offs of COP efforts often come forward in business units, and not in the COP where the efforts have been made. The recognition of the added value of knowledge workers to support their self-esteem is an important part of hosting. Metrics visualize the added value of knowledge workers.

## **2.5 Combining intentional Fociss and emerging MKM innovations: a way towards a realized sustainable innovation strategy**

Fociss offers the structure and methods to develop sustainable innovations and MKM supplies a driver for unleashing creativity and further development of the inventions. In this study, we look for a conjunction of these methods that may generate a range of innovative sustainable options and that consequently secure their implementation. We believe that this is possible because they have several similarities and may provide each other support in specific situations.

1. Both methods are aimed at generating and realizing knowledge-intensive innovations. Fociss offers a matrix and workshops for variation and selection, whereas MKM is aimed at making a playing field for knowledge workers and hosting management.
2. Both apply a systems approach in which systems levels and complexity are assessed. Fociss applies a three level systems approach (production – production chain – societal context) and fills these layers with the relevant issues of and around the organization. The MKM approach supplements this systems approach with a general modular prescription for the appropriate levels of coordination competences (improvisation – routines – standardization) at the different levels of the system,

based on the complexity and changeability of the relevant functional competences (see figure 2 and 7).

3. Both grant an important role to the relevance of personal values and trust between workers and their management. For Fociss, an important condition for combining short term and long term issues is the involvement of all company staff. It explicitly tries to create shared insight and vision through all sectors in a company, involving also outside stakeholders, suppliers, customers and NGO's. The MKM approach views the evolvement of the "post-capitalist" society (Drucker, 1991) as important, where companies shift from making products to offering services and sense for customers, employees and investors. Therefore, it follows the suggestion of Seely Brown that "we must focus on the shared sense of place...and find ways to foster intellectual capital that becomes inextricably bound to a sense of personal meaning" (Brown, 1999).
4. Both methods have an orientation on long term issues such as sustainability of the business, integrity and work-life balance. This is not to say that direct profitability and pressing concerns are irrelevant. On the contrary, Fociss combines the search for innovations issues with direct profit spin-off. Within MKM the development of systemic metrics is a central issue, to support the knowledge worker in his idea about the value his own work. Obviously, this involves intrinsic motivation and empowerment of highly educated (and often autonomously operating) employees at the heart of bottom-up innovations (Amabile, 1998; Sennett, 1999).

The differences and similarities between the methods bring us to the following *proposition*:

The scope of the innovations and the level of realization of Fociss will increase by the support of MKM.

By means of an explorative study within a shipbuilding company in the Netherlands, we will look for ways to develop a conjunct approach.

### **3. Methods**

#### **3.1 Introduction**

In the theory above, we have described the opportunity to mingle the top-down approach from the discipline of Sustainability Studies, which offers sustainable initiatives from a long-term, systematic perspective, and a bottom-up approach from the discipline of (Knowledge)

Management Studies. This latter defines a modular set of competencies and, consequently, draws the architecture for coordination between the knowledge workers. This offers them the playing field for knowledge transfer to ‘autonomously’ develop innovations. In this explorative study we verify how Fociss and MKM may ‘lift’ each other.

Students participating in the minor Sustainable-Technical Innovation Management at Avans Hogeschool have gathered data at IHC Merwede, a ship building company that offers design and construction activities for the specialist maritime sector. They have separately applied a Fociss scan and a knowledge management scan.

### 3.2 Fociss-light

The basic characteristics of the Fociss approach (priority setting, core business oriented and stepwise structured focussing) are explained elsewhere (Venselaar 2010a,b). Fociss is also used as a model in teaching ‘sustainable innovation strategy development’ in management as well as in technical studies. For instruction the approach is somewhat adapted into ‘Fociss-light’ wherein it is a framework and model to assess a business without a complete set of interviews and workshops.

IHC Merwede has several business units concentrated in three clusters. IHC Merwede has a sustainability focus at strategic level and embraces “technological innovation” (IHC’s core competence) as the main tool for reaching sustainability goals on the middle and long term planning (MLTP). For instance, IHC Merwede has chosen to enter sustainable markets such as wind energy. In the future, this centralized policy will set the pace for individual business units to take sustainability into account. At present times, each unit pays attention to specific sustainability issues.

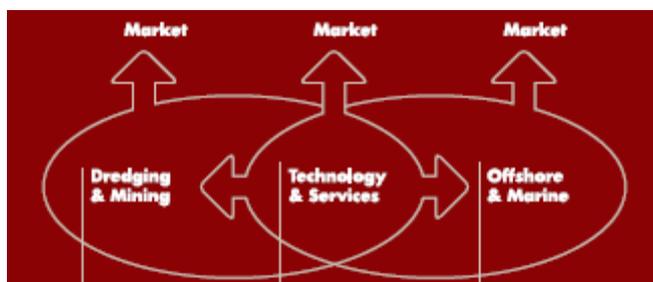


Figure 5: Three clusters of business units of IHC Merwede

This study focuses on the cluster of Dredgers and Mining.

The major steps that students have performed in this Fociss-light study are the making of research questions, the definition of interview questions to find out what sustainability issues are relevant for Dredgers, and the creation of the matrix for the overview of all issues and prioritization between issues.

### **3.3 Modular knowledge management (MKM) scan**

Subsequently, students have started the MKM by means of five face-to-face interviews within Dredgers to typify the functional and coordinating competences. Besides, an interviewee of another business unit has been spoken with and four additional digital interviews have been added to put the answers in a broader perspective.

The data have been studied to score the functional and coordination competences in terms of difficulty (functional) and range (coordination). The procedure to score these competences has elaborately been dealt with in Breukel et al (2009).

- The difficulty of functional competences is a composite variable on a 10 point scale that is the average of complexity and variability (Perrow, 1970; Adler, 1995).
- Coordination measures range from 1 (very strong standardization) to 10 (very strong improvisation).

Consequently, a gap analysis is performed that compares the required (SOLL) coordination with the present (IST). This analysis has further been supplemented by filling in questionnaires on knowledge strategy, processes and facilities (Ropes & Stam, 2008.).

Finally, suggestions have been worked out that indicate possible helpful organizational constructs and knowledge management instruments at Dredgers.

### **3.4 Combining the methods**

After the presentations of students, the authors have conducted interviews at IHC to discuss the results of both methods and to explore how MKM may support Fociss to attain the proposed sustainability innovations.

## **4. Results**

### **4.1 Sustainability results for IHC Merwede by means of Fociss-light**

The following Fociss issues have been found during the interviews.

- A. In many areas people migrate to coastal areas. This increases the need for safety and dredging.
- B. Low income countries such as China may form a possible competitive threat for the present incumbents of the industry.
- C. Extraction in ecological areas requires specialist maritime knowledge (e.g. in the Wadden Sea).
- D. Exhaustion of raw materials, including fossil energy, increases the interest for extraction in different areas (e.g. deep sea).
- E. More strict environmental measures, including taxes, are imposed by the authorities.
- F. Individuals apply a more sustainable attitude so that sustainability becomes a recurring demand.
- G. Sustainability issues are still under pressure due to costs, especially during an economic crisis.
- H. Emissions of ship engines (more details are given below).
- I. Dredging companies are forced by their customers to pay more attention to sustainability, sometimes resulting in window dressing.
- J. Different business units plea for different sustainability measures (such as less waste or less energy).
- K. New technologies emerge to decrease pollution.
- L. Proposals are developed to take sustainability into account in the strategic goals of different business units.
- M. Higher energy costs for customers may prevent purchase.
- N. High maintenance costs may deter clients.
- O. Development of niche markets asks for specialist solutions.
- P. Embargos to dredge in nature areas.
- Q. Cooperation to increase knowledge, e.g. with suppliers.
- R. Development training in other (e.g. Chinese) languages.
- S. Changing sea level (more details are given below).
- T. Dismantling old dredging ships (more details are given below).

These issues have been clustered in the Fociss matrix (see Table 2) on the two axes of 'production process stages' and 'sustainability aspects'.

Table 2: Fociss matrix of IHC Merwede

Sustainability aspects in process, product and production chain		En- vi- ron- ment	Pur- cha- se	Engi- neer- ing client design	Produc- tion	Technical services & parts	Trai- ning	Sup- port	Client
Criteria									
planet / fysical aspects	Usage of energy	H		E	E	E			M
	Usage of resources		J	D J T	D J	D T			
	Direct environmental impact on health	H P S		D T	D S T	D T			
	Impact on space and location	P							
people / social and cultural aspects	Nature and ecology	S P	J	J	J	T			
	Labor conditions				S	N	R	Q	
	Safety / quality of living	H P							A
	Global impact	S				N	R		I M
Prosperity / added value	Market opportunities	B		D K	D K	D	R	G L Q	A F O
	Reputation and trust by market and civil society	P			T	T		G	F I M N
	Contribution to local and global prosperity	S					R		

Consequently, students have used the Kesselring method to find the issues with the highest priority (see Figure 6) based on questions about ‘the degree the customer appreciates the issue’ (y-axis) and ‘the degree to which the organization (Dredgers) may respond’ (x-axis).

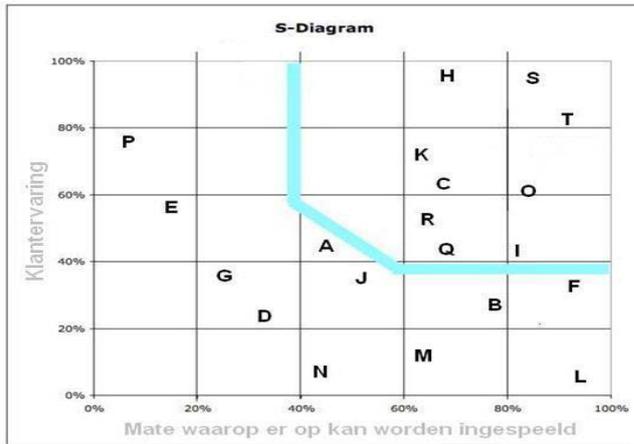


Figure 6: Priority setting of Fociss issues

This has resulted in the choice for three issues: H, S and T.

H. Emissions of ship engines.

Ship engines need much fuel. Dredging vessels even need more fuel because they need more engine capacity for dredging equipment. This issue can be tackled by means of using renewable sources or through the increase of the efficiency of engines. At present times, the latter option is preferred because of the costs of implementing machinery that is based on renewable energy.

S. Changing sea level (increase or decrease).

Different causes lead to coastal erosion, which endangers the hinterland. This offers potential new orders for participants of the dredging industry.

T. Dismantling old dredging ships.

The dismantling of old ships often takes place at shores in Asiatic countries in irresponsible ways, which puts pressure on the health of the involved workers and the quality of local ecosystems. Social, environmental but also economic reasons may result in a different way of dismantling ships in this industry.

We can typify these issues as follows:

- H: emission: sustaining and incremental.
- T: dismantling: perhaps disruptive and radical.
- S: sea level change: sustaining but radical.

Additional interviews at IHC Merwede have revealed that these proposals are part of its core business and may support the future position of the company. IHC Merwede is already working on that issue of the emissions of the Dredgers (H) that, having high levels of energy consumption, must be reduced or rendered harmless for nature. IHC Merwede is now exploring how to link such initiatives for a company-wide effective sustainability strategy. We study how MKM may be part of his effort.

#### 4.2 The modular competences of IHC Merwede

The analysis of the interviews has delivered the following functional and coordinating competences (see Table 3 and Figure 7).

Table 3: Scores of the functional competences

Functional competence	Variability	Complexity	Difficulty
F1: Sales	4	2	6
F2: Production	2	2	4
F3: Make Order	4	4	8
F4: First Design	4	2	6
F5: Service	-	-	-
F6: Order Processing	4	2	6
F7: Technology	4	4	8
F8: Implementation	2	4	6
F9: Detail Design	2	2	4

The higher the average difficulty of a modular unit, the more the appropriate coordination competence shifts from standardization via routines towards improvisation.

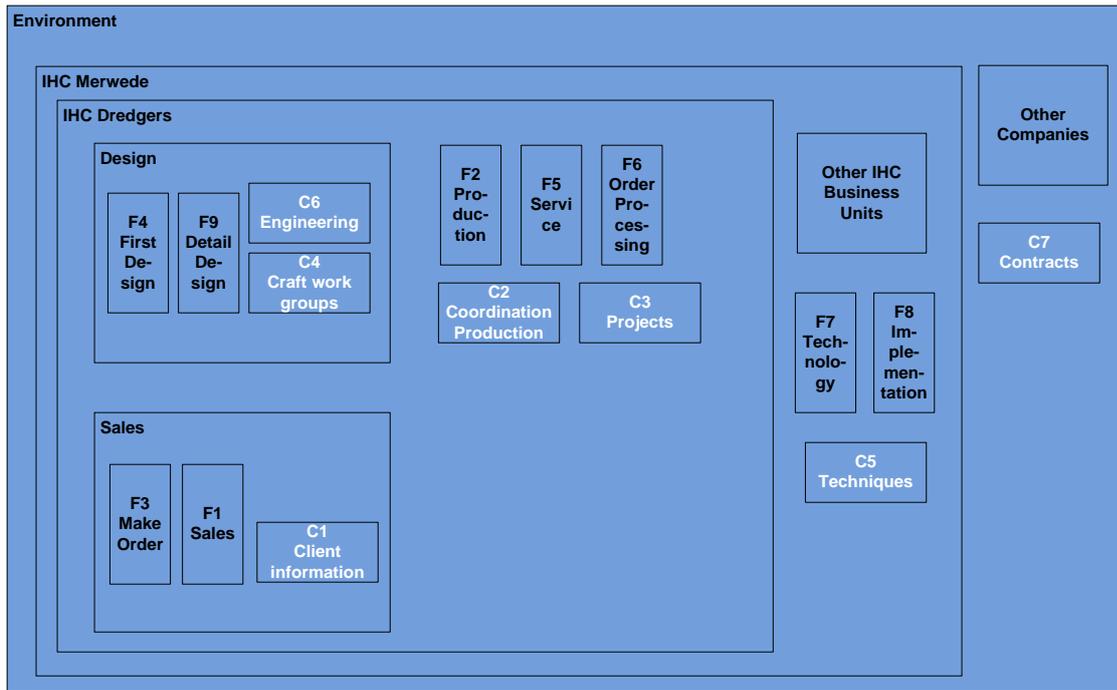


Figure 7: The modular scheme of competences of IHC Merwede

Next, we calculate the difficulty of the modular units at higher levels (see Table 4).

Table 4: Scores of the higher order functional competences

Module: Design	Difficulty
F4: First design	6
F9: Detail design	4
Average	5

Module: Sales	Difficulty
F3: Make order	8
F1: Sales	6
Average	7

Module: Dredgers	Difficulty
Average module Sales	7
Average module Design	5
F2: Production	4
F5: Service	-
F6: Order Processing	6
Average	5,5

Module: IHC Merwede	Difficulty
Average module Dredgers	5,5
F7: Technology	8
F8: Implementation	6
Average	6,5

At present times, coordination competences have the following values (see Table 5):

Table 5: Scores of the coordination competences

Coordination Competence	Present coordination score
C1: Coordination of client information	7: improvisation supplemented with routines
C2: Coordination of production	4: standardization supplemented with routines
C3: Coordination of projects	5: routines supplemented with standardization
C4: Coordination of craft work groups	6: routines supplemented with improvisation
C5: Coordination of techniques	6: routines supplemented with improvisation
C6: Coordination of engineering	6: routines supplemented with improvisation
C7: Coordination by contracts	3: standardization partly supplemented with routines

The competences at the deepest level have relative more reciprocal relations than the competences at higher levels. This puts a relative higher pressure (+2) on the coordination at these levels. This is especially the case for:

- Sales with an increased complexity score of 9. Sales is coordinated by C1, which requires many improvisatory elements (coordination score of 9).
- Design with an increased complexity score of 7. Design is coordinated by C4 and C6, which requires improvisation supplemented with routines (coordination score of 7).

Such an extra pressure is also the case, but to a lesser extent (+1), for the modular units of Dredgers with a complexity score that rises to 6,5 because it has internal interactive relationships. Dredgers is coordinated by C2 and C3, which should offer sufficiently rich coordinating knowledge by means of routines (average coordination score of 6,5)

IHC Merwede as a whole has a complexity score of 6,5 and is coordinated by C5. It should be coordinated by means of routines (average coordination score of 6,5)

The gap analysis suggests that the coordination values of C1 (7 → 9) for Sales and the average of C2 and C3 (4,5 → 6,5) for Dredgers are relatively too low to deal with the functional complexity, and that the average score of C4 and C6 (6 → 7) for Design and the score of C5 (6 → 6,5) for IHC Merwede are slightly too low to coordinate effectively.

The students have proposed three mechanisms to support specific coordination competences in order to close the gaps.

**BD Groups: C5**

Business unit Development Groups (BD Groups or PDA groups) are cross-functional working groups with members from different business units. These groups support the transfers of knowledge between units, and may support creation of new knowledge by recombination of ideas in different contexts. These groups could be based on technical issues such as welding techniques, ICT, hydraulics and so on.

**Yellow pages: C3, C4 and C5**

Yellow pages link the personal profile of persons to email facilities so that yellow pages stay up-to-date. This is known as semantic software. It directs requests to the relevant persons and looks for people within the subject area.

**Wiki's: C2, C3 and C4**

A wiki is a digital system that transfers explicit knowledge within an organization. It is produced and used by involved members of a community (such as a company).

These options are positioned within the framework (see Figure 8) of Dyer & Nobeaka (2000).

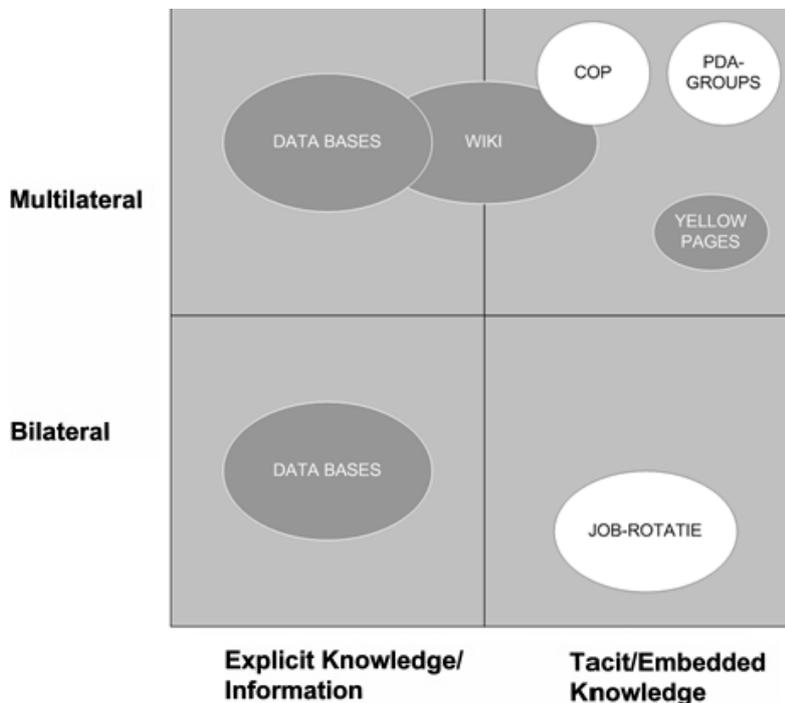


Figure 8: Positioning the mechanisms in the framework of Dyer and Nobeaka (2000)

### 4.3 Mixing knowledge management and sustainability innovations

Additional interviews have shown that IHC Merwede is already closing the presented gaps by means of the discussed wiki's with a yellow page system, starting January 2010, informing the employees in May 2010 and with increasing traffic until July 2010 (last measurement).

More important, however, is the need *for making presently dispersed information digital* (so that employees can have access to earlier experiences), supporting the coordination of client information (C1) and *the formation of virtual communities* around specific themes such as 'vibrations' and 'hydro mechanics'. These communities offer more interaction and knowledge transfer between involved organization members, especially when embedded in the wiki.

*The ID program* fits with this approach. Novel ideas are presented for a selection committee, and the petitioners of the selected ideas will be active in the realization of the idea. These mechanisms such as communities and the ID program, with the element of ownership and delegation, support the variation and later realization of innovations. They are not a part of a dual structure, but they are integrated within the organization. It will afford IHC to align initiatives with their existing activities and to ensure continuity individual workers the space to manifest their creativity. In this way, the challenge of 'stretch' and 'support' is met by means of contextual ambidexterity.

The discussed initiatives show that knowledge management has an obvious place in the organization and able to support sustainability initiatives. For instance, several brainstorming sessions have addressed a wealth of research subjects and alternatives for possible solutions and actions such as the re-design and innovation of the production process and the equipment itself, with a careful eye being kept on the total life cycle (Ports and Dredging, 2009). This involves implementing sustainability in the products and the production processes, the 'greening of the production' and anchoring it in the mindset of the workforce. This issue was not generated by means of Fociss but at present IHC Merwede already deals with this issue, not only because it concerns knowledge intensive innovation in which different system levels and units but especially because of relevance of personal values and the orientation on long term issues (both part of the required the mindset of organizational members).

The main result of this study is that the case of IHC Merwede demonstrates that the on the one hand the Fociss-light scan has delivered sustainable issues within the core business of

which some did not come to full realization, while on the other hand knowledge workers develop other challenging sustainable initiatives, partially due to the emergence of virtual communities and wiki's with yellow pages, concerning the 'greening' of the production with a careful eye being kept on the total life cycle.

This brings us to the following line of reasoning when it concerns the leverage that MKM can give to Fociss and so to underline the research proposition. We suggest starting with a MKM scan in order to verify the level of knowledge management within a company. The implicit question "are there sufficient organizational mechanisms and tools to support the coordination between the functional competences" leads to an answer where or not there is a difference between required and prevailing coordination competences. Then, based on this answer, we may differentiate a follow up between two situations.

1. If a company has functioning bottom-up mechanisms for coordination by means of improvisation and routines, than we suggest that Fociss is initiated at the level of the workplace where knowledge workers are active. The resulting Fociss issues and innovations are then emerging from existing communities. Management needs to foster and connect these ideas (between communities, with the rest of the company) and should finally select between the proposals. Fociss makes the yields of the sustainable innovations visible (indicating advantages in terms of people-planet-prosperity) in the value chain processes of the industry, although it does not offer concrete metrics. In this way, Fociss offers transparency to the knowledge workers because it shows organizational members how and where their efforts indeed may result in genuine value. This approach helps organizations with the development of more complex sustainable innovations with a wider reach (see the up & right quadrant of Figure 2).
2. If a company does not have the required coordination competences, or does not have a presence of bottom-up activities, then Fociss can start top-down but all stakeholders must directly be involved to create shared insight, vision and priority setting. The performance of Fociss should simultaneously take place with the start of decentralized project groups for internal discussions between cross-functional units in order to contribute to realistic future options. This approach is not only aimed at the content of sustainability issues, but also at the intention that the work floor will take ownership of these issues. These issues may then become the incentive for further

development of communities within the framework of the functional and coordination competences.

## **5. Conclusions and further research**

We conclude that this paper has shown a suitable approach for knowledge driven sustainable innovations from a combination of top-down and bottom-up approaches.

The incorporating of sustainability in the company strategy will strengthen the company's basis and profitability, certainly in the longer term (Bhattacharyya 2007). Therefore, sustainable innovations should be directed by company-wide goals, which are intertwined with the system of competencies. The difficulty for the management is that they do not have all relevant information at its disposal because external and internal developments are unpredictable and the systemic nature of competences is often highly complex (Grant, 1996). Therefore, the management experiences uncertainty about the realization of possible innovations. Organizations need to learn how to involve the knowledge of their educated knowledge workers in order to explore and exploit opportunities for radical but achievable innovations (Ciborra, 2002; March, 1991). The field of Knowledge Management offers organizations mechanisms, such as COPs, to support such involvement (Hildreth et al., 2000).

The case of IHC Merwede shows how Fociss, starting for a top-down perspective, has indeed delivered a mixture of incremental and radical innovations. Especially incremental innovations were being developed, whereas on the other hand developing communities with more bottom-up attitude were trying out other novel ideas. This situation may be a prelude to incorporate Fociss into those emerging communities, of which the people are still working in their own department. This development is in line with the concept of contextual ambidexterity where the need for innovation and on-going business are met within a specific business unit (Gibson & Birkinshaw, 2004). In longer term, this may even lead to a change in company goals, although always within the framework of the organization's ideology (Collins & Porras, 1996).

We have suggested two trajectories to combine Fociss and MKM. In both situations a repository of ideas is being developed, of which some can directly be introduced (alignment to support exploitation) whereas others are more elaborate and should be timed based on environmental development (adaption for exploration). This approach creates more variation,

a more direct link with the realization and requires a different role for management such as fostering, connecting and selection (Burgelman, 1991). This integration has made Fociss more dynamic; starting from the core business, it now is able to generate more variation and not only able to find but also to retain innovations, even if they concern the (re-)definition of organizational goals. In this way it aligns with the view from Hubbard who has stated that the effectiveness of sustainable management should be related with activities of the actual core business but especially that every organization would have to define its system uniquely (Hubbard, 2009).

We have to take into account that the present result of Fociss is less elaborate because students have performed a Fociss-light scan. A more elaborate Fociss scan might have given an image more in line with already communities-based activities. However, the list of issues was elaborate, and later interviews have not resulted in a different selection. Another restriction is that Fociss has originally been developed for SMEs that are not active in sustainability strategy whereas IHC Merwede is a multinational with attention for sustainability. This does, however, not imply that Fociss cannot be applied to look for improvements. A related issue is the question how SMEs, having small numbers of staff at their disposal, can create effective communities of knowledge workers. Prahalad & Ramaswamy (2004) and Huston & Sakkab (2006) suggest cooperating fully with suppliers, clients and partners, with the intention to combine knowledge in order to attain an open business model (Chesborough, 2006).

The approach of combining Fociss and MKM based on the KM situation promises to be a good basis for training students in 'sustainable business innovation management' and offers opportunities for further research. Graduate students may be involved in a study to perform an elaborate Fociss study initiated by developing communities of IHC Merwede, while management may grow into a different role and metrics are being developed. This study will research the impact of this unfolding on the variation, scope and realization of sustainability issues. Based on these results, we can modify the alignment between the Fociss and MKM approaches and take the results back to the minor Sustainable-Technical Innovation Management at Avans Hogeschool.

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