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Competitive Sustainable Manufacturing (CSM) Hotel

Investigating from a managerial perspective

Master of Science Thesis

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Abstract

This thesis has an intention to investigate a proposal, CSM-Hotel. The proposal is an answer of a call from EU to have a project about eco-factories. Thus, this research aims to investigate further the proposal from a managerial perspective since Chalmers is one of the members of consortium which owns CSM-Hotel and plays a role on management matters. There are three research questions in this thesis. Sustainability is the first issue addressed and needs to be investigated whether CSM-Hotel meets requirements as sustainable organization. Although there are some indicators of sustainability organization, only environmental dimension is satisfied by CSM-Hotel. The second issue is management structure of CSM-Hotel. A collaborative structure was proposed to accommodate paradigms within CSM-Hotel i.e., holonic and self-organizing systems, and sustainability. The last issue is to determine factors that benefit of CSM-Hotel. Since CSM-Hotel to some extends is similar to eco-industrial parks (EIPs) based on their characteristics argued in literature, the evaluation therefore utilizes EIP instead of starting from scratch. This thesis revealed that CSM-Hotel does not only gain benefits obtained by EIP, but also overcome problems and barriers faced by EIP and gain benefits from them.

Keywords: CSM-Hotel, sustainability, collaborative, EIP

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Gothenburg, May 2011
Temi S. Budijono Kurniawan

Abbreviations

CNO : Collaborative Network Organization

CSM : Competitive Sustainable Manufacturing

EFFRA : European Factories of the Future Research Association

EIP : Eco-Industrial Park

EU : European Union

ICT : Information and Communication Technology

OEM : Original Equipment Manufacturer

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1 Introduction

This chapter explains background of this study, purposes and research questions that guide the study, method on how to conduct the study and delimitation that provides limitation of the study.

1.1 Background

On 20 July 2010, the European Factories of the Future Research Association (EFFRA) called applications for 'Factories of the Future' that have two themes: (1) Nanosciences, Nanotechnologies, Materials & New Production Technologies, and (2) Information and Communication Technologies (ICT). In regard to the first theme, a consortium of several universities and research centers; working together with science parks, manufacturing companies and manufacturing service providers in Europe, proposed a project called 'Next Generation Eco-Factories (CSM-Hotel)'. This project is related to one of the topics called, the eco-factory: cleaner and more resource-efficient production in manufacturing.

Mats Winroth, an Associate Professor in Operations Management Division at Department of Technology Management and Economics, is presented from Chalmers University of Technology as a part of the consortium. In the meantime of approval for the proposal from the EFFRA, he wanted to investigate CSM-Hotel from a managerial perspective. Therefore, three research questions were addressed and used to guide this study. The proposal therefore became the main source regarding the data or information of CSM-Hotel.

The project of CSM-Hotel that was proposed by seven European countries, adapts the holonic, networked and open eco-factory concept planning for the future. By means of manufacturing green products in clean processes, the business sustainability and new-generation of eco-city development would be supported. A CSM-Hotel is like business clusters serving with common resources; for example, waste treatment and logistics to its tenants. Besides there are vacancies in CSM-Hotel for the companies to rent as factories, in this context, the companies also work as partners creating ownership of the hotel together.

Therefore, the CSM-Hotel refers to a business network that shares similar standards, guidelines and norms, and has a core that standardized intelligent negotiation process is used for cooperation. Furthermore, the management needs to ensure hotel's operations continuously support sustainability particularly in resources utilizations and waste treatments.

1.2 Purpose and research questions

This thesis aims to investigate how a CSM-Hotel can be managed together by all partners in a sustainable manner. To achieve the objective of this research, three research questions were addressed:

1. Which dimensions of sustainability relate to CSM-Hotel and in what way?
2. Which management structure could be applicable to CSM-Hotel in order to support sustainability of CSM-Hotel?
3. Which benefits can a partner gain from CSM-Hotel?

1.3 Method

Since this study intends to investigate the content of a proposal or document this study fell under qualitative research while the suitable method to be employed was content analysis (Bryman & Bell, 2007). Therefore, the proposal was used as the main source of data. To formulate an approach of this research, ontology and epistemology of this study were set. Ontology is about claims and assumptions thus, in this study, the ontology was about the idea of developing a CSM-Hotel. Moreover, epistemology is about how to obtain data, so, for this study, it was decided to be an investigation, particularly from a management perspective.

The data selected from the proposal is analyzed by triangulation with the theories. Three research questions were used to guide the research of theories in three different areas i.e., sustainability, collaboration, and eco-industrial park. Therefore, there were different theories relating to each research question. The Chalmers

University of Technology Library was used to search and retrieve relevant literatures.

The analysis was conducted by investigating the selected parts of the proposal to answer research questions which was later triangulated with theories. A conclusion was drawn from the analysis in order to answer the research questions. To give more value to this research an additional chapter, managerial implication, was added. This chapter was intended to provide ideas and factors that managers might need to consider.

1.4 Delimitation

Since this study has been limited by time and available funds this study was only conducted for three and half months. Furthermore, these limitations were also narrowed down the scope of analysis so this study was decided to only focus on managerial issues and did not deal with production system design or ICT-solutions of the holonic system.

2 Theoretical Framework

This chapter reviews literature used in this research. Section 2.1 gives introduction of sustainability, its indicators in sustainable development and Competitive Sustainable Development (CSM). Section 2.2 provides description of collaboration, self-organizing systems paradigm, holonic paradigm and collaborative framework. Section 2.3 explains about eco-industrial parks.

2.1 Sustainability

2.1.1 General

Sustainability is a broad concept that has three domains: economy, society and environment as shown in figure 2.1 below.

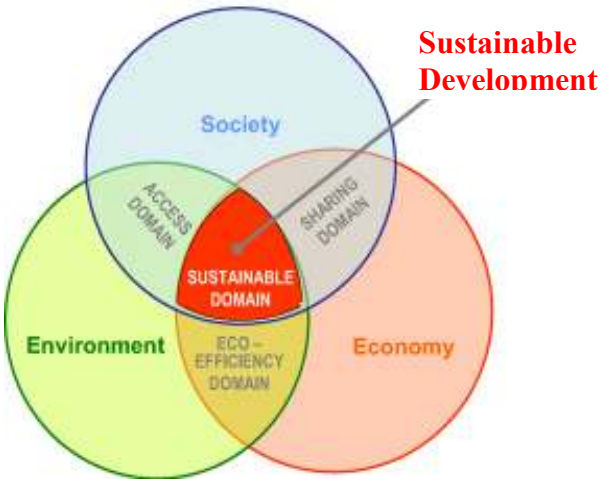

Figure 2.1 Fundamentals of Sustainable Development

Jovane et al. (2008) grouped sustainability into three levels: at macro level (macro-economic), meso level (production and consumption paradigms) and field level (product/services, processes and business models) while Almstrom et al. (2011) identify four levels of aggregation of sustainability: global, national, corporate and factory level.

Reviewing the EU Sustainable Development Strategy (SD), there are four key objectives: environmental protection, social equity and cohesion, economic

prosperity, and meet international responsibilities. These objectives were aimed to prevent seven key challenges identified: climate change and clean energy, sustainable transport, sustainable consumption and production, conservation and management of natural resources, public health, social inclusion and demography and migration, global poverty, and sustainable development challenges (Council of European Union, 2006).

Furthermore, the Swedish government addressed strategies for sustainability development, including 12 headline indicators, to the Swedish Parliament in 2005 (Swedish Government Communication, 2005). Thus, the strategies toward sustainability development were emphasized: building sustainable communities, encouraging good health on equal terms, meeting the demographic challenge, and encouraging sustainable growth.

2.1.2 Indicators of Sustainable Development

There are three dimensions in sustainable development: environmental, economic and social, as summarized by Almstrom et al., (2011). Each main indicator has their own indicators that each of them also has one or more sub-indicators. Furthermore, Azapagic & Perdan (2000) proposed indicators of sustainability as a framework for industry based also on the three components of sustainable development as shown in figure 2.2 below.

Figure 2.2 shows that the first category of indicators is environmental indicators that based on a life cycle approach, which considers the supply chain of materials and energy that illustrate a whole picture of interactions between human activities and environment. These indicators have three main categories: (1) environmental impacts that some of them affects environmental locally while some others affect environmental globally; (2) environmental efficiency illustrates how smaller is more sustainable since material and energy intensity determine the total amount of materials and energy used to produce a product; and (3) voluntary actions that are related to a proactive response of business to environmental problems.

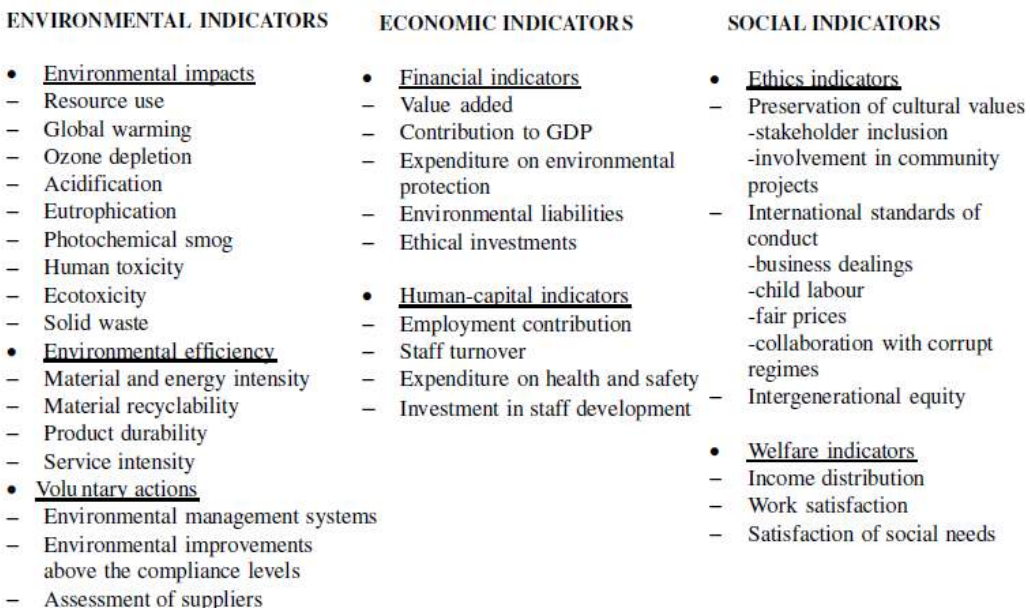

Figure 2.2 Indicators of sustainable development for industry: a general framework

Furthermore, the economic indicators cover not only monetary or economic capital but also human capital thus there are two types of indicators included, financial and human. Financial indicators measure the economic performance in conventional monetary terms and human-capital indicators evaluate economic aspects related to the work force.

The last category is social indicators that focus on corporate social responsibility. These indicators illustrate the relationships between human well-being and business activities. Thus, there are two generic types of indicators: ethics and welfare. Here, many ethical variables are hardly to be quantified and also cannot be defined in physical terms. However, it is still possible to measure them consistently and comparably across organizations by using qualitative ethical indicators. Similarly, human welfare is not an easily defined concept either.

2.1.3 Competitive Sustainable Manufacturing (CSM)

Jovane et al. (2008) stated that the main enabler of sustainable development is a new paradigm – *Competitive Sustainable Manufacturing (CSM).* There are two characteristics of the CSM; it is high added-value and also knowledge-based. Jovane et al. (2008) saw that there are interactions between research, education

and innovation, which are called as knowledge triangle (figure 2.3) and they are the key drivers of knowledge-based society. Consequently, there is a comparative concept that measures ability and performance of an actor (firms, universities, research centers) to respond demands better than others. This concept was defined as competitiveness and together with sustainability can be achieved by developing and implementing new high-added-value and knowledge-based products, services, processes and business models.

In a different way, Koho et al., (2010) stated that sustainability includes and presupposes competitiveness therefore to include a term competitiveness would not be necessary. They explained that combining competitiveness and sustainability aim to emphasize efforts towards sustainable manufacturing and should not be seen as additional costs, but sources of competitiveness and competitive advantage.

Figure 2.3 The knowledge triangle

2.2 Collaboration

2.2.1 General

Collaboration aims to respond to fast economic, social, environmental and technological changes (Jovane, 2009). Therefore, collaboration should take place across all kinds of borders, between companies, research institutes and universities, suppliers, customers, and other players in the network since complexity and distribution of different activities takes a form of a network (FutMan, 2003). Various knowledge is gained in response to different challenges and this knowledge has developed various skills and expertise that are required in

interactions of integrated-kind of environmental shared information and also in achieving mutual agreements (Kamrani et al., 2008).

Camarinha-Matos (2008) illustrated the evolution in manufacturing system (figure 2.4) that emphasizes progressive levels of integration by identifying the introduction time of new approaches and paradigms. He stated that inter-enterprise collaboration is becoming more and more important.

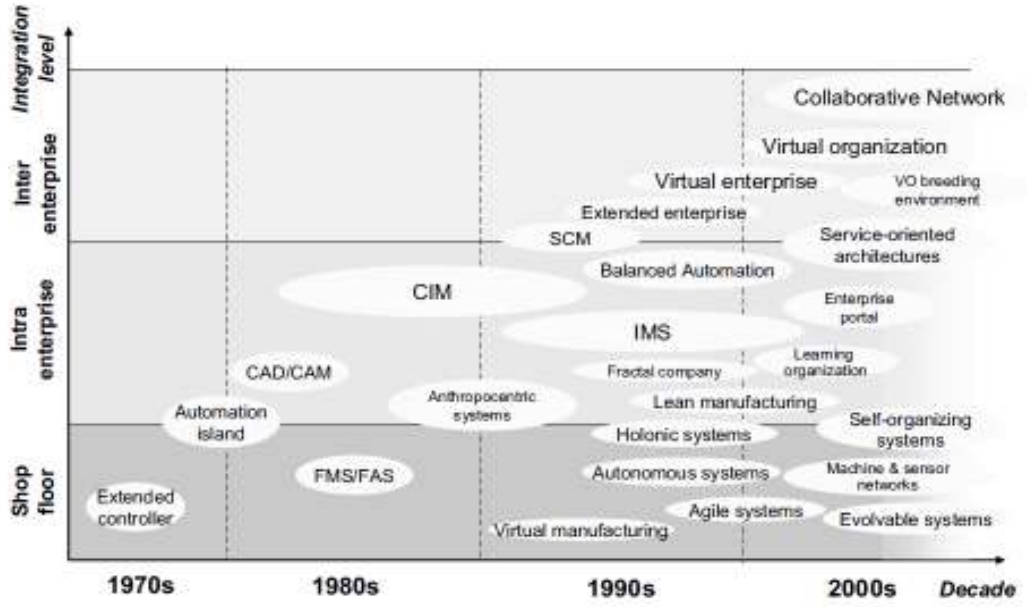

Figure 2.4 A brief historic evolution in manufacturing systems

2.2.2 Self-organizing systems paradigm

In order to develop such self-organizing characteristics that lead corporate to a higher integration level, there is a need to develop structures and processes. Danilovic & Winroth (2006) proposed four dimensions to be used for better understanding of integration. The dimensions are the scope, the surface, the time horizon and the intensity of integration.

Self-organizing system is developed through: (1) strategic conversation which may clarify areas of authority and responsibility; (2) participation of all partners that together have more understanding of the picture of 'the world' rather than each of them having their own; and (3) creating direction and accountability through

situational visibility because direction does not come from hierarchy but from understanding strategic aspect of the whole business situation network.

Therefore, Danilovic & Winroth (2005) proposed a tentative framework, with four dimensions, to analyze integration in collaborative manufacturing network settings as described below:

- Surface of integration has focus on 'What' is integrated in collaborative networks in terms of the output of the integration process either production only or product development, logistics, etc.
- Scope of integration has focus on 'Who' is coordinated in terms of individuals and 'Whose' work in terms of tasks and organizational routines.
- Time horizon of integration has focus on 'When' integration is conducted either it is occasional or long lasting.
- Intensity of integration has focus on 'How' integration is conducted in terms of the density of activities among actors and in communication patterns.

Here, by considering robust network setting, there are dynamics relations between corporations and people that need to be handled to modify 'What' and also 'Who' dimensions in different phases of molding the product. Moreover, the network has to be legally supported while organizational routines enabling intense collaboration are established. These are needed to make the collaborative network robust and long lasting.

2.2.3 Holonic paradigm

The concept of holonic is based on autonomous and co-operative units. Autonomy refers to units that are able to perform their tasks without any help from other units while co-operation enables them to communicate with each other to achieve their shared objectives (Nylund et al., 2008). The holonic organization provides stability in facing disturbances, has adaptability and flexibility when facing changes, and is able to efficiently use available resources (Brussel et al., 1998).

There are three types of basic holons: order holons, product holons and resource holons (Brusells et al., 1998). Each type is responsible for one aspect of manufacturing control. They are structured using aggregation and specialization. Here, aggregated holons refer to a set of related holons that are clustered together to form a bigger holon with a new identity. Furthermore, specialization is used to differentiate holons according to their characteristics. Additionally, staff holons can be added to assist the basic holons to perform cooperation with expert knowledge.

All holons are self-similar across different specializations. The natural heterogeneity of system components is reduced by modeling them as homogeneous as possible and creating the main interface functions that are common to all holons. Holarchies become holons in a higher holarchy while vertical self-similarity is only illustrated for resource holons by their nature. Thus, holons have different ontology from different point of views and to develop a holarchy meta-controller contains the 'rules of the game'.

Ulieru et al. (2001) stated that a holonic enterprise is a holarchy of collaborative enterprises, where the enterprise is regarded as a holon (the term enterprise is used in a broad, generic manner: entity, system, 'thing', or agent). The holonic enterprise follows the relationship-based enterprise paradigm that shift at all levels of a cluster of collaborative organizations by blending the holonic manufacturing systems (HMS) and multi-agent systems (MAS). It has three levels of granularity: global inter-enterprise collaborative level, intra-enterprise level, and machine (physical agent) level.

The development of complex systems would benefit from the use of a holonic approach which enables workflow management through robust e-business models that channel the flow of information throughout the ecosystem partnering. Patterns of holonic collaboration have metamorphic architecture pattern which works by synergetic integration of dynamic virtual clustering and mediator agent pattern.

2.2.4 Collaborative Framework

Camarinha-Matos & Afsarmanesh (2007) stated the importance of considering both aspects, internal and external, of a Collaborative Network Organization (CNO). Therefore, there are two modelling perspectives: endogenous that sees the network from inside and exogenous that sees interactions between the CNO and its surrounding environment (figure 2.5).

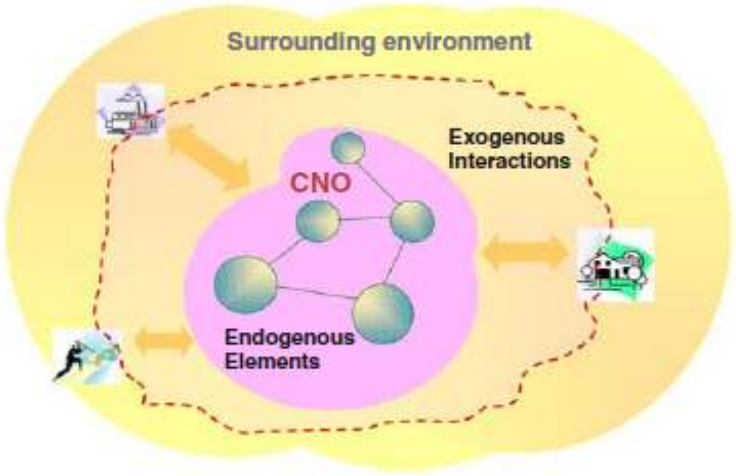

Figure 2.5 Two modelling perspective

Camarinha-Matos & Afsarmanesh (2007) proposed dimensions and sub-dimensions for endogenous elements and exogenous interactions within a CNO modeling framework as follows.

Endogenous elements

1. Structural dimension

- Actors/relationships—identifying all the participating actors in the network as well as their inter-relationships. The actors can be enterprises, other types of organizations, or people. Two, or more, actors can be linked through a number of different types of relationships; for example, client-supplier, sharing, co-authoring, etc.

- Roles—describing and characterizing roles of actors in the network. A role defines an expected behavior for an actor in a given context. Examples of roles include member, coordinator, broker, planner, etc.

2. Componential dimension

- Hardware/software resources—characterizing the equipment, software, and infrastructures used/shared in the network. Here, ICT equipment is including architecture of the computer network supporting the collaboration while manufacturing networks can be included a layout of shared facilities and logistics networks.

- Human resources—referring to people available in the network that is including their competencies, profile, potential roles they can perform, etc.

- Information/knowledge resources—including repositories of information and knowledge shared by the network members or support collaboration processes and networked organization.

- Ontology resources—representing main or common ontology used in the network that facilitates mutual understanding among network members. An example is ontology of competencies available in the network.

3. Functional dimension

- Processes— concerning processes involved in the main line of activities of the collaboration. Processes represent the main structured part of the operational activities of the network. An example is the distributed business processes in a business oriented CNO.

- Auxiliary processes—including those processes designed to assist the CNO's maintenance and improvement of operations. Examples include performance monitoring processes, competencies management processes, etc.

- Methodologies—representing the body of practices, procedures, and rules used mainly by human actors in a CNO, typically less formalized than processes. They are frequently represented as a semi-structure set of steps (informal enumeration of activities) combined with some structured representation of input/ output information. An example can be the methodology to be followed by a broker to announce a business opportunity to the CNO members.

4. Behavioral dimension

- Prescriptive behavior—capturing the elements that lie down or prescribe normative guidelines or rules for the proper behavior of the CNO such as (general) principles, strategies, and protocols. An example is a recommendation for CNO members to give preference to network peers when searching for partners for a business opportunity. Another example could be the recommended protocol when negotiating a contract.

- Obligatory behavior—describing those mandatory rules and principles to be followed inside the network. This includes policies, governance values and associated rules, and enforcement steps. An example can be the internal rules used for distribution of benefits or for sharing the operational costs of the network.

- Constraints and conditions—representing those "environmental features" that limit the context of operation of the CNO and its members. An example is a set of restrictions on the use of intellectual property of one member by other members of the network.

- Contracts and cooperation agreements—covering both contracts between the CNO and external customers, and internal contracts and cooperation agreements among the network members. These models may include both representations understandable to humans and to software systems.

The following picture is an illustration that theories or paradigms such as self-organizing systems, multi agent systems or holonic could be applicable to build CNO framework.

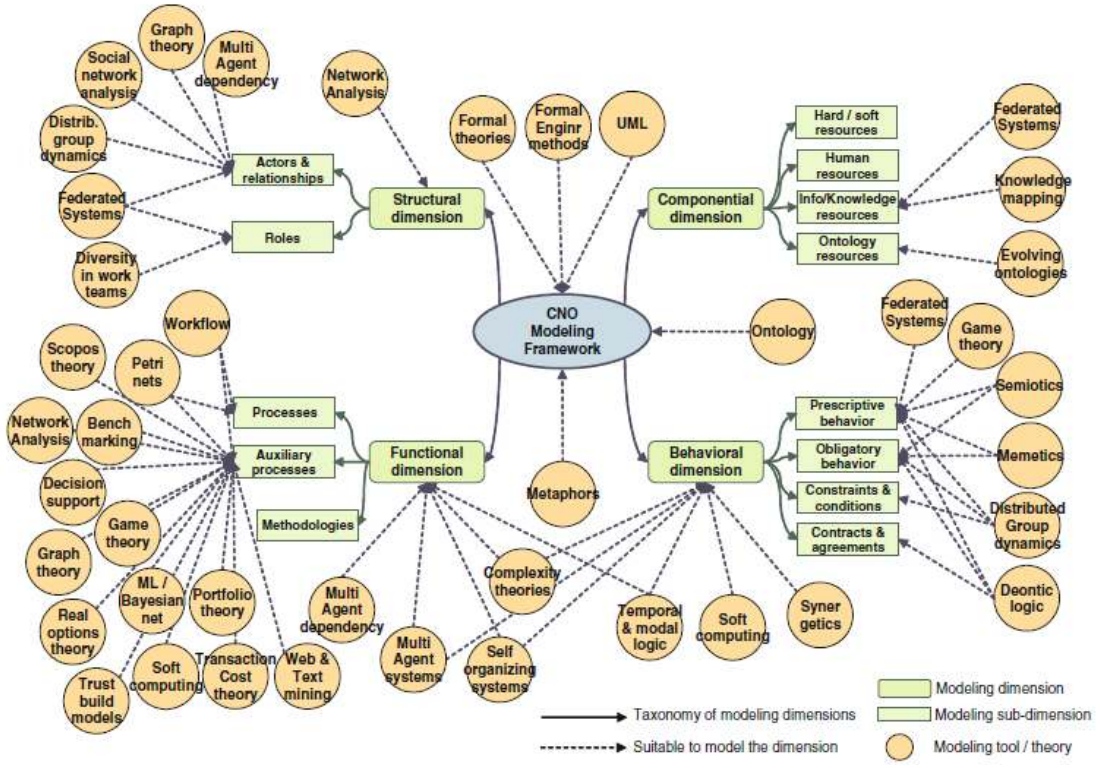

Figure 2.6 An attempt to map modelling theories applicable to CNOs

Exogenous interactions

1. Market dimension

This dimension covers both issues related to interactions with "customers" (or potential beneficiaries) and "competitors". The customers' facet involves elements such as transactions and established commitments (contracts), marketing and branding, etc. On another hand, competitors' issues are included market positioning, market strategy, policies, also missions of the CNO, its value proposition, and joint identity.

2. Support dimension

This dimension relates to support services provided by third party institutions; for examples, certification services, insurance services, training, external coaching.

3. Societal dimension

This dimension captures issues related to general interactions between the CNO and the society. Although it has a very broad scope, the idea of this concept is modeling the impacts of the CNO that possibly affects society (e.g., impact on employment, economic sustainability of a given region, potential for attraction of new investments) as well as the constraints and facilitating elements of the society provided to the CNO development (e.g., legal issues, public body decisions, education level).

4. Constituency dimension

This dimension focuses on interactions with universe of potential new members of the CNO. The interactions are such kind of interactions with organizations that are not part of the CNO but interesting to be included. Therefore, some considerations are paying to some factors; for example, sustainability of the network, attraction factors, what builds/provides a sense of community, or specific aspects such as rules of adhesion and specific "marketing" policies for members.

2.3 Eco-industrial parks

Cote & Cohen-Rosenthal (1998) stated that there are several characteristics of eco-industrial parks (EIPs), which are needed to be considered. The characteristics are as follows:

- define community interests and attract the community to involve in designing the park;
- reduce environmental impact or ecological footprint through substitution of toxic materials, absorption of carbon dioxide, material exchanges and integrated treatment of wastes;

- maximize energy efficiency through facility design and construction, co-generation, and cascading;
- conserve materials through facility design and construction, reuse, recovery and recycling;
- link or network companies with suppliers and customers in the wider community in which the eco-industrial park is situated;
- continuously improve the environmental performance of individual businesses and of community as a whole;
- have a regulatory system, which permits some flexibility but still encouraging companies to meet performance goals;
- use economic instruments, which discourage waste and pollution;
- employ an information management system, which facilitates the flow of energy and materials within a more or less closed-loop;
- create a mechanism which seeks to train and educate managers and workers about new strategies, tools and technologies to improve the system;
- orient its marketing to attract companies, which fill niches and complement other businesses.

Moreover, Gibbs (2003) claimed that EIPs are based on industrial ecology concepts that attempt to combine both product competitiveness and environmental improvement or increase business performance while reducing pollution and waste. Here, the members of EIP, which are manufacturing and service business, work in collaborative way as a community seeking enhanced environmental and economic performance through managing environmental and resource issues including energy, water, and materials.

However, a number of potential barriers to develop of the EIPs were identified. According to Gibbs (2003), there are technical, information, economic, regulatory, and motivations barriers. In addition, trust, sometimes, may also be included as a barrier; for example, companies may not trust to provide information about production processes because of competitive reasons. A related problem is that the partners in EIP may be over-dependent on each other and it might lead to inertia and a lack of innovation within companies.

Nevertheless, there are benefits of EIPs as stated by Chertow (2007). He mentioned there are three primary opportunities: resource exchange by-product reuse, shared utility or infrastructure and joint provision of services. Resource exchange refers to exchange of firm-specific materials between two or more parties for use as substitutes for commercial products or raw materials. Shared utility or infrastructure is defined as pooled use and management of commonly used resources such as energy, water, and wastewater. While joint provision of services is meeting common needs across firms for ancillary activities such as fire suppression, transportation, and food provision.

Historically, the EIP proved there are some other benefits; for example, 'spontaneous co-location' of businesses in industrial districts has been shown to give rise to many public and private benefits including labor availability, access to capital, technological innovation, and infrastructure efficiency. The benefits also can be seen that there have been advancing projects, including economic development broadly, remediation of pollution associated with heavy industry, water and land savings, and greenhouse gas reductions. Furthermore, from regulatory perspective for instance in the United States, according to Chertow (2007), the Public Utilities Regulatory Policy Act (PURPA) bestowed certain pricing benefits on facilities willing to co-generate steam and electricity. Even when a law does not directly command reuse, projects could get a less tangible 'license to operate' in the form of regulatory permits or greater social acceptance.

To be more specific, there were two studies conducted by Gibbs (2003) and Chertow (2007) in Kalunborg, Denmark. They have similar conclusion that

Kalunborg is a reference of success EIP project because Kalunborg sysmbiosis emerged from self-organization initiated in the private sectors to achieve their objectives; for example, cost reduction, revenue enhancement, business expansion, and securing long-term access to water and energy. Furthermore, Kalunborg implements a coordinate function that was found to be helpful in organizing more exchanges and moving them forward once a revelation was made.

3 CSM-Hotel

This chapter describes, mainly, information from the proposal. The data selected only that were related to management issues and limited by tasks under responsibilities of Chalmers University of Technology. This chapter has eight sections. Section 3.1 gives explanation of the CSM-Hotel concept. Section 3.2 provides context of the CSM-Hotel. Section 3.3 describes content of the CSM-Hotel. The objectives, strategies, paradigm and platforms, scientific and technological goals, and ICT framework are described in section 3.4 to section 3.8, respectively.

3.1 Concept

CSM-Hotel is designed to provide an open complex rapid constant platform for: fast adapting sustainable urban context, manufacturing industry to provide sustainable employment, and innovative clean manufacturing of green products for sustainable business at point of need.

The CSM-Hotel concept is the operation model for platforms to interoperate inside the local platforms and among other platforms. The concept adopts learning and adaptive system that will improve its conditions over time. The concept also provides constant sustainable and competitive manufacturing efficiency and effectiveness improvement within holistic eco-factory context instead of a single project based, partial optimizations without continuity. Thus, the whole CSM-Hotel network shares the same standards, guidelines, principles, and norms. Consequently, the CSM Hotel is standardized intelligent negotiation process for cooperation.

3.2 Context

The context of the CSM-Hotel combines economics of scale and scope of the concept within eco-industrial area context. Scale is provided by CSM Hotel network and scope by tenants. CSM Hotel context operates as open complex service oriented platform where there are multiple roles operating in constantly changing multicultural environment. Current eco-factories are mostly monocultures hosting

rather rigid case-optimized processes whose change costs are high. Also there is lack economy of scale in, at least, one of the competitive dimensions knowledge, capabilities, competences, and/or cooperation. To remove these rigidities, CSM-Hotel is a role based on relaxed stability structure allowing constant change and effectively addressing all competitive sustainability dimensions, typical roles are hotel owner, tenant, service provider, client OEM, and site owner.

3.3 Content

During the project, several processes are planned, implemented, evaluated, and improved. Once any best practice approved, it will be made explicit. This requires efficient role based shared competence and capability management for efficient cooperation and knowledge sharing on mutual platform. Wide support services, both locally and globally, are provided. Thus individual companies (tenants) can concentrate on improving their scope processes and CSM Hotel concentrates on improving the context, its processes and services.

3.4 CSM Hotel Objectives

CSM-Hotel objectives are to collect the best practices and approaches of the consortium to level up the standard, norms, and guidelines to create a constantly updating common knowledge and expertise base for continuous improvements. Therefore, a CSM-Hotel world class beyond lean competitive sustainable level is created.

CSM Hotel is a harmonized and pragmatic eco factory approach for the consortium and aims at concrete rapid rise of the level of both context and content for effective and efficient network integrating the following stakeholders:

- European best manufacturing OEMs with their best eco-factory solutions to harmonize with their supplier sharing CSM-Hotels aiming at the same level;
- European manufacturing SMEs sharing same CSM Hotel;

- European best service providers having already high state of the art level (technological, ICT, management, organizational services) for new holistic solutions;

- Research centers, universities, and learning factories to provide the support; and

- European major sustainable urban city development and their eco-industrial areas to provide the context for new standard development.

3.5 CSM-Hotel Strategy

CSM Hotel is an idea originated from strategic needs of most advanced sustainable manufacturing industry and its most advanced service providers for long term cooperation. CSM Hotel strategy stated that an eco-factory is not a single effort but an ongoing process of continuous improvements and innovations where the success of implementation depends on the implementation process. The interaction with green product and clean process for sustainable development within eco-industrial area requires a holistic approach. If one only seeks to improve an existing process by implementing additional eco-technology, the solution seldom improves total efficiency and usually has unintended side effect. The autonomous CSM Hotels are networked for the core expertise group. Thus, providing a platform for other CSM Hotels to join and provide reference architecture for similar initiatives. Similar settings are created inside the OEMs eco-factories.

3.6 CSM-Hotel Paradigm and Platform

CSM Hotel concept is envisioned to be a new holistic open complex system eco factory paradigm for sustainable industry with roots in HMS (Holonic Manufacturing Systems), FrMS (Fractal Manufacturing Systems), BMS (Bionic Manufacturing Systems), and CF (Cognitive Factory) research.

There are four integrative dimensions that are vital for the open complex platform to provide the anticipated results:

- Capability dimension – rapid improvement and fast implementation of latest sustainability and manufacturing technologies depend on the ability to match offered capabilities to needs.

- Competence dimension – fast adaptation and use of new solution depending on fast competence development.

- Open cooperation dimension – innovativeness, efficiency and effectiveness of the CSM-Hotel network depend on efficient self-initiated cooperation and network building on point of need.

- Knowledge dimension (system intelligence) – knowledge is a dominant competitiveness factor combining with competences and capabilities.

These emergent systems express emergent properties beyond the roles. The strong links of the system attract needed partners and allow constant change on combining link structures for rapid adaptation. Within open complex platform all actors (holon) form role-based systems (holarchys) on point of need with these roles:

- Tenants; for example, SMEs as entrepreneurs and competence providers

- OEMs; as owners and end users and also platform appliers

- Advanced eco-city infrastructures; for example, Tampere, Wien, Ljubljana, Stuttgart, Gothenburg, Zlin, with strict standards as eco-context for harmonic evolution towards sustainable paradigm

- Eco-factory infrastructure providers; for example, Science and Technology Parks, Service Providers, OEMs, and other

- Eco-factory services; for example, technology providers, ICT providers, management providers, organization development providers, here, the better cover the more credible consortia

- Research cooperation providers; for example, universities, research centers.

The core stakeholders of CSM-Hotel consist of four basic actors: eco area provided by cities, CSM Hotel owner, service providers, and tenants. Furthermore, CSM Hotel operation is based on four domains: management (business) domain, organization domain, ICT-domain, and technology domain shared and formed by actors according to their role (role based open complex system).

CSM-Hotel project consists of five independent autonomous (holonic) eco-manufacturing platforms connected to role (service) based on Digital Virtual Core Platform as an open complex system (holarchy) that allow fast adaptation of new roles (services) and their self-integration based on intelligent negotiation process. Each platform has similar internal structure and operates common standards, norms, and principles. Each platform is capable to add new processes and services, and also new CSM-Hotels. Moreover, in order to create truly holistic next generation Eco-Factory each platform consists of an eco-industry area a state –of-the-art Eco-Factory, sustainable technology service providers, Science Park, University, and eco city. The project consists of five local platforms and one connecting virtual platform.

3.7 Scientific and Technological Achievements and Goals

The already achieved results from consortium's eco-factories focusing on resource efficiency are impressive. Key figures:

- Energy consumption/product has decreased about 70% by energy optimization of resources and machines tools, minimizing standby, ramp-up times and logistical operations with best practices knowledge.

- Use of renewable energy has decreased about 30% by integration of renewable in site planning with smart and dynamic and intelligent scheduling based on available resource capabilities and integration to smart grids.

- Water consumption/product has decreased up to 75% by adapting new eco-technologies such as dry machining processes, re-use of water supply and advanced water purification technologies that exist today but are not integrated in holistic way. Consequently, water out is clearer than water in.

- Waste produced/product has decreased up to 60% by avoidance of shape cutting, reduction of waste material and deficient products due to the better understanding of resource capabilities. Thus, it also created zero waste-landfill.

- VOC (Volatile Organic Compound) emissions/product has decreased about 70% by enabling the adoption of dry machining technologies, avoidance of unnecessary lubricants, application of less volatile compounds and by utilizing advanced HVAC technologies. Therefore, it also produced zero non-filtered emission.

CSM Hotel will harmonize sustainability content and context within eco-factory, its manufacturing and production in relation to:

- Prevent environmental pollution (or turn it to resources) by providing latest innovative solutions and evaluation means. It uses resources and energy in production.

- Reduce global resources consumption, such as particular energy usage, by offering latest means and expertise for evaluating alternative manufacturing technologies to resource intensive manufacturing processes.

- Use and develop efficient synthesis methods of sound concepts and multi-objective process simulation of analysis, enabling a more sustainable, efficient, competitive, and clean manufacturing of high value-added green products.

- CSM Hotel provides integration of monitoring tools based on common key environmental performance indicators (KPI) over CSM Hotel net and either

local or remote smart components that collect and process information about the product's whole ecological footprint.

3.8 CSM ICT Framework

The purpose of the CSM ICT framework is to combine all services within companies into single entity that have all capabilities and restrictions. For instance, if a customer requests a service or combination of services then companies in the framework will work together to satisfy service required. Here, if an external service demand arrives to the CSM ICT framework therefore the best company in the framework will be determined to handle the service. The process of selection of the best company will depend on demands characteristics. Once a company is selected, the process continues to select the best suited factory to handle the demand while then the most suitable system inside the floor is selected. If a service cannot be completed by only one resource, the service request needs to be divided into several sub-requests. The response to the demands will be sent back by following the same process upstream. The whole processes interpret demands or requests from abstractive to concrete pattern.

4 Analysis

This chapter describes analysis of the relation between sustainability and CSM-Hotel, collaborative management structure, and the benefits of CSM-Hotel. There are three sections in this chapter. Section 4.1 explains the analysis of relation between sustainability and CSM-Hotel. Section 4.2 describes the analysis of collaborative management structure. Finally, section 4.3 provides details of benefits of the CSM-Hotel.

4.1 Sustainability and CSM-Hotel

Scholars from various disciplines discussed sustainability from different perspectives since they have been motivated by different interests. However, it was interesting to understand sustainability defined by two institutions: Governmental institution and Research institution.

Governmental institution was represented by Swedish Government and The European Union Council (EU). The motivation to choose them was because the funding Chalmers mainly got was from Swedish Government and the call to submit CSM-Hotel proposal was from the EU. Research institution was represented by universities. The motivation to choose papers from universities was because of significance of the papers to sustainability for CSM-Hotel.

Swedish Government had eighty seven indicators of sustainable development under twelve headlines. Those indicators were said as a tool. It was a useful instrument on which to base discussion and for monitoring the evolution of a sustainable society, for the Government and the general public, business, organization and agencies concerned. Furthermore, those indicators were argued to be able to broadly reflect various aspects of sustainable development. However, there was no set of indicators that had been generally accepted. Even, it had been worked up. Thus, the chosen set of indicators would be subject to ongoing method of development efforts. It would be changed whenever warranted by improved statistics, methods of measurement or analytical insights.

On the other hand, the EU was still developing the indicators at the appropriate level of detail to ensure both a comprehensive and in-depth coverage of the complexity of sustainable development. The development at the appropriate level was also intended to ensure proper assessment in regard to challenges such as climate change and clean energy, sustainable transport, sustainable consumption and production, etc. The EU would further develop and review indicators of sustainable development to increase their quality and comparability as well as their relevance to the renewed Sustainable Development Strategy. Moreover, the EU also took into account other indicator initiatives and focused on those indicators marked as most needed.

Therefore, it could be concluded that there were no fixed set of sustainable development indicators endorsed yet either at national level-Sweden or regional level-Europe. Considering this reason, two articles came from research institution were studied to find their applicability and then to be employed in order to investigate which dimensions of sustainability CSM-Hotel relates to.

First article was an article from Almstrom et al. (2011). This article provided indicators of sustainable production. The indicators are grouped into three dimensions of sustainability: environmental, social, and economic, and there are sub-categories for each indicator. The indicators were quite detailed to accommodate corporate level, particularly for manufacturing firms. However, CSM-Hotel lays more at industry sector level instead of corporate level. Sustainable development indicators for industry sector level were more general compared to those at corporate level. This leveling actually had been discussed in this article by mentioning four levels of aggregation: global, national, corporate, and factory level. Industry sector level lay between corporate and national level. In addition regarding leveling, Jovane et al. (2008) also mentioned three levels of aggregation: macro level, meso level, and field level.

Second article was an article by Azapagic & Perdan (2000) that provide indicators of sustainable development for industry. The indicators were developed in a general framework. This framework was considered to be relevant for CSM-Hotel

because the indicators were general to cover different entities within CSM-hotel. This framework was also based on three dimensions of sustainable development. Following is the analysis to investigate which dimensions of sustainability CSM-Hotel relates to.

Environmental dimension

Indicators for environmental dimension were grouped into three sub-dimensions: environmental efficiency, environmental impacts and voluntary actions. Regarding environmental impacts, CSM-Hotel proposal mentioned that consortium's eco-factories were already able to reduce energy and water consumption by 70% and 75% per product respectively. Energy consumption could be reduced by energy optimization of resources and machines tools, minimizing standby, ramp-up times, and logistical operations with best practices knowledge. Water consumption could be reduced by adapting new eco-technologies such as dry machining processes, re-use of water supply, and advanced water purification technologies. Those technologies were also able to make water out cleaner than water in. Although those technologies were already existed, they were not integrated in a holistic way.

Moreover regarding environmental impacts, waste could be reduced by 60% per product by reduction of waste material and deficient products due to better understanding of resource capabilities. There was zero landfill that was achieved by avoiding shape cutting. VOC emissions were reduced by 70% per product and zero non-filtered. Both of them could be achieved by enabling the adoption of dry machining technologies, avoidance of unnecessary lubricants, application of less volatile compounds and by utilizing advanced HVAC (Heating, Ventilating, and Air Conditioning) technologies. VOC emissions related to human-toxicity or eco-toxicity. Furthermore, CSM-Hotel would prevent environmental pollution or even turned it become resource and energy by utilizing latest innovative solutions and evaluation means. CSM-Hotel would reduce global resources consumption by utilizing latest means and expertise for evaluating alternative manufacturing technologies.

Regarding environmental efficiency, CSM-Hotel consortium's eco-factories used renewable energy by 30% of total energy consumption. It could be achieved by integration of renewable with intelligent and dynamic scheduling in site planning based on available resource capabilities. Moreover, CSM-Hotel would use and develop efficient synthesis methods for sound concepts and multi-objective process simulation for analysis. Both methods and simulation would enable a more sustainable, efficient, competitive, and clean manufacturing of high value-added green products.

Regarding voluntary actions, CSM-Hotel would provide integration of monitoring tools based on a common Key Environmental Performance Indicators (KEPI) over CSM-Hotel network. The tool were either local or remote smart components that collected and processed information about the product's whole ecological footprint, Moreover, the proposal stated that CSM-Hotel aimed at concrete rapid rise of the level of both context and content for effective and efficient network. This network integrated European best manufacturing OEMs (Original Equipment Manufacturer) with their eco-factory solutions to harmonize with their suppliers.

Economic dimension

Indicators under economic dimension that has two sub-dimensions: financial and human-capital, were not explained clearly in the proposal. However, since the idea of CSM-Hotel was from CSM paradigm that high added value, CSM-Hotel could be assumed to already address an indicator under sub-dimension financial: value added. Moreover, indicators under sub-dimension: human-capital employment contribution, staff turnover, expenditure on health and safety, and investment in staff development could be assumed covered by the concept of CSM-Hotel. This concept was designed to provide sustainable employment for innovative clean manufacturing of green products for sustainable business at point of need. However, aforementioned indicators: value added, human-capital employment contribution, staff turnover, expenditure on health and safety, and investment in staff development would be better to mention or explain clearly in the proposal

instead of based on assumption. Other indicators were not mentioned explicitly or implicitly and, therefore, could not be possible to make any assumptions either.

Social dimension

Indicators under social dimension that had two sub-dimensions: ethics and welfare were not mentioned at all. Even though this dimension that focus on corporate social responsibility by relating human well-being to the activities of business could be considered and added later when CSM-Hotel would be established. However, without addressing issues concerning human rights, cultural values, equity and disparity within the current population and between current and future generation, the assessment of sustainability would be incomplete (Azapagic & Perdan, 2000).

4.2 Collaborative Management Structure

4.2.1 Paradigms in Collaboration

The form of CSM-Hotel could be concluded as collaboration between different parties since its members varied from manufacturing firms to universities. It raised questions about what kind of collaboration would be suitable and what paradigms could be applicable for CSM-Hotel.

In the proposal of CSM-Hotel, holonic paradigm would be used particularly in production systems. This paradigm, according to the literature, was originally utilized to manage the activities at shop floor level, more into machines and tools. However, several researchers (e.g., Ulieru et.al.) were thinking that holonic was also applicable for inter-enterprise collaboration. According to holonic enterprise the supply chain paradigm was replaced by the collaborative holarchy paradigm. Thus, each firm or entity in one platform could be assumed as a holon and the aggregation of them or the platform was holarchy.

The concept of holonic paradigm was autonomous and co-operation. Therefore, each entity in the platform worked autonomously and co-operatively. This idea of autonomous or managing the entities by themselves was also used by CSM-Hotel in

the proposal. The purposes of that idea were to accelerate the reaction as the responses of changing and to avoid unnecessary escalation to the higher levels which would reduce the resource consumptions. Moreover, regarding co-operative the proposal mentioned that communication within the form of co-operation was required in CSM-Hotel to enable the exchange between entities within CSM-Hotel. The supportive infrastructure, for instance the ICT would follow this requirement.

Furthermore, there were driving forces of the collaboration. First one was the need to group the best partners as the optimal clustering, and second one was the need to balance the autonomy of each individual partner with the co-operative demands of the collaborative cluster through negotiation that could range from simple bidding to complex argumentation and persuasion strategies. Those forces could be accommodated by holonic paradigm: autonomous to balance the autonomy of each individual and co-operative to group the best partners. Moreover, self-organizing systems paradigm could also accommodate those driving forces with clarifying the scope, surface, time horizon, and intensity of the collaboration. For instance, regarding the scope: who the partner in CSM-Hotel and what their responsibilities, the surface: what the output of the collaboration process, the time horizon: occasional or long lasting, and the intensity: how deep the activities and how to communicate. In addition, regarding the negotiation, CSM-Hotel already addressed this by using standardized intelligent negotiation process for co-operation as the core of CSM-Hotel.

Therefore, holonic paradigm and self-organizing systems paradigm were concluded to be applicable for the collaboration in CSM-Hotel. In addition, both holonic and self-organizing systems have been discussed in literature to have possibilities to be applied at inter-enterprise level. This fact gave more reasons to employ these two paradigms in CSM-Hotel.

4.2.2 Comprehensive collaborative framework

During conducting literature review several frameworks of collaborative organization were revealed. However, only two frameworks were further studied. First framework was so called holonic enterprise. This framework was considered

suitable for CSM-Hotel because its idea came from holonic paradigm. This paradigm was also a paradigm that CSM-Hotel would use. However, how to build a structure of holonic enterprise was not explained explicitly.

Another framework that was found and further studied was considered comprehensive. It provided perspectives from both internal and external. Moreover, it was also practical on the implementation since the structure was explained in detail and explicitly.

This collaborative organization had two perspectives or structures. First one was internal structure or endogenous. It had four dimensions: structural, componential, functional, and behavioral. These dimensions could accommodate theories from other fields. For instance, functional and behavioral dimensions could apply paradigms in CSM-Hotel such as self-organizing system or holonic.

Second one was external structure or exogenous. It had four dimensions as well: market, support, societal, and constituency dimension. These dimensions could accommodate sustainability. For instance, economic sustainability was applied in market dimension, social sustainability in social dimension, and environmental sustainability in support dimension. In addition, CSM-Hotel was intended to be a collaborative organization that brought sustainability in its management structure and processes.

Furthermore, this framework could be expected to constitute the basis for the ICT-based support for CSM-Hotel's business and organizational development and operation, as well as the base for education, training, and effective operation of CSM-Hotel. Framework was fundamental for understanding, managing, simulating/predicting the behavior of the collaborative organization, and certainly also for software development.

In addition, this collaborative framework also considered the life cycle dimension and a stratification of models according to the modeling purpose. Therefore, it could be concluded that this model was comprehensive and suitable for CSM-Hotel.

4.2.3 Sustainable Holonic Collaborative Management Model

A management structure model is proposed here to be used for CSM-Hotel. Its name is Sustainable Holonic Collaborative Management Model. The name is created as reflections of the content of the model. Sustainable means that the model brought sustainability, particularly in term of three dimensions of sustainable development. Holonic means that the model employed holonic paradigm for its operations. Collaborative means that the model was managed in collaborative way.

Following is the explanation of the model structure based on its dimensions. The explanation is made as detailed as possible to show what this structure would look like, but further elaboration is still required.

Endogenous - Structural

This dimension consists of sub-dimensions: actors/relationships and roles. Based on CSM-Hotel proposal there are four basic actors. These actors are the core stakeholders of CSM-Hotel: eco area provided by cities, CSM-Hotel owner, service providers, and tenants. Moreover, CSM-Hotel operations are based on four domains; management (business) domain, organization domain, ICT-domain, and technology domain. These domains are shared and formed by actors according to their roles. Typical roles are hotel owner, tenant, service provider, client OEM, and site owner. Furthermore, CSM-Hotel project consists of EU-wide virtually integrated development platforms that are maintained by local universities or research centers. Integration is done by an operational team that shares the standards, approaches, tools, and produces the documentation. Most of the work is done via virtual net-meeting and a virtual society.

Endogenous - Componential

One sub-dimension under this dimension is information/knowledge resources that consist of several elements: product/service model, business process model, performance data, and lesson learned. These elements can be fulfilled by the core expertise group that is networked within the autonomous CSM-Hotels. The group

provides a platform for other CSM-Hotels to join and references architecture for similar initiatives.

For other sub-dimensions require to be further elaborated. Following is examples of elements for each sub-dimension. Hardware resources consist of shared machinery, ICT infrastructure. Software resources consist of management services, common collaboration support tools. Human resources consist of human actors performing a role in CSM-Hotel. Ontology resources consist of general ontology, profile & competencies ontology of CSM-Hotel members.

Endogenous - Functional

The processes in CSM-Hotel are managed in a cycle: plan, implement, and then evaluate. Since CSM-Hotel will learn from what has been done, thus improvement of the processes will be part of the cycle after evaluation. Moreover, best practices that are obtained during the process will be approved and standardized. The approving and standardizing require efficient role. This role is based on shared competence and capability management for efficient cooperation and knowledge sharing on mutual platform. Furthermore, wide support services, both locally and globally, are provided. Thus, individual companies (tenants) can concentrate on improving their scope processes and CSM-Hotel concentrates on improving the context, its processes and services. In addition, CSM-Hotel objectives are to collect the best practices and approaches of the consortium to level up the standard, norms, and guidelines to create a constantly updating common knowledge and expertise base for continuous improvements. Furthermore, CSM-Hotel concept is envisioned to be a new holistic open complex system eco factory paradigm for sustainable industry with roots in HMS (Holonic Manufacturing Systems).

Auxiliary processes that facilitate the changing within CSM-Hotel are accommodated through contract management process and re-organization process. Moreover, such processes those supporting transparencies are provided. Conflict resolution procedure, decision making procedure, and decision communication procedure as parts of methodologies within functional dimension are important to be available as well.

Endogenous - Behavioral

Prescriptive behavior is fulfilled with formulating management approach, profit distribution rules, and risk sharing rules. Obligatory behavior is defined with activity reporting rules, performance reporting rules. Constraints & conditions are fulfilled by contractual constraints, resource use constraints. Contracts & agreements are made for both between CSM-Hotel and external customers and between CSM-Hotel members.

Exogenous - Market

In this dimension, the focus is on CSM-Hotel partner's relations with customers and competitors. The partners in CSM-Hotel can be competitors for the others with purposes to gain benefits. It will give advantages for the partners to compete with competitors from outside CSM-Hotel. Moreover, these competitive advantages will support sustainability, particularly for economic dimension. Furthermore, the relations with customers are built and tightened with providing complete offerings as collective products or services produced by each partner. Sharing information between the partners regarding potential customers is established.

Exogenous - Support

Other parties outside CSM-Hotel that provide services for CSM-Hotel are required to be secured. The purpose is to ensure CSM-Hotel will get support uninterruptible. The services are, for instance, insurance services and certification services. Moreover, natural resources that also support CSM-Hotel are secured by applying environmental sustainability in CSM-Hotel.

Exogenous - Societal

Social sustainability is applicable to be put in this dimension since according to the sustainable development, ethics and welfare indicators have to be considered as important of business activities.

Exogenous - Constituency

This dimension considers interactions with other parties that are not the partners of CSM-Hotel yet but CSM-Hotel may be interested to attract them. CSM-Hotel will be attractive if it is able to prove as a profitable organization and have many advantages compared other collaborative organizations.

4.3 The benefits of CSM-Hotel

4.3.1 Eco-industrial parks versus CSM-Hotel

Referring to the characteristics of eco-industrial parks stated by Cote & Cohen-Rosenthal (1998) and the argumentation from Gibbs (2003), CSM-Hotel could be understood to be similar with Eco-Industrial Parks (EIP). Thus, a question might arise why not build EIP instead. The answer would be provided by using a statement mentioned in the proposal of CSM-Hotel: '*in order to create truly holistic next generation Eco-Factory, CSM-Hotel as a platform consists of an eco-industry area a state-of-the-art Eco Factory, sustainable technology service providers, Science Park, University, and eco city*'. Interpretation from the statement was that one part of CSM-Hotel was eco-industry area or Eco-Industry Park. Thus, indeed CSM-Hotel might be similar with EIP, only CSM-Hotel had more elements such as Science Park, Universities, etc. This reason was used to investigate CSM-Hotel using EIP as departing point to figure out benefits for a partner that could be gained from CSM-Hotel. The investigation was started by discussing similarities and differences between CSM-Hotel and EIP, and followed by discussing barriers and problems faced by EIP that could be overcome by CSM-Hotel, and lasted by discussing key factor and weaknesses of EIP that could be secured and eliminated respectively by CSM-Hotel.

Similarities between CSM-Hotel and EIP could be mentioned as follows. Both of them tried to combine competitiveness and environmental improvement. They increased business performance while reducing pollution and waste. They worked in collaborative way in managing environmental and resource issues including energy, water, and materials. The collaboration between members assisted them in

maintaining competitive advantage. Their concepts were inter-firm collaboration and networking, based upon trust and reciprocal relations. The members could be encouraged to form into networks where knowledge and innovation were both generated and shared.

The difference between EIP and CSM-Hotel could be seen from members' characteristics. The members of EIP were manufacturing firms and service business. Whereas, CSM-Hotel members were not only manufacturing and service firms but also universities or research institutes, science parks, and eco-cities. Universities or research institutes, particularly, differentiated CSM-Hotel to EIP. They could generate theories based on best practices obtained by CSM-Hotel members. The theories could be expected not only providing closed loop of learning process within CSM-Hotel but also could be used and became references for other parties outside CSM-Hotel.

As stated by Gibbs (2003), EIP faced a number of potential barriers such as technical, informational, economic, regulatory, and motivational barriers. CSM-Hotel could overcome these barriers using four domains in the operation of CSM-Hotel: organization, management, technology, ICT domain; and four integrative dimensions: capability dimension, competence dimension, open cooperation dimension, and knowledge dimension. Explanations on how CSM-Hotel could overcome those barriers are presented as follows.

Technical barrier made local industries difficult to fit together. It could be overcome by CSM-Hotel Partnership that enabled by advanced competence management. Informational barriers made difficult to find new uses of waste products, relating to poor information regarding the potential market and potential supply. It could be overcome by CSM-Hotel Management that enabled by advanced knowledge management. Economic barriers inhibited the incentive to use waste streams as a resource if there was no reliable market for them. It could be overcome by CSM-Hotel Technology that enabled by advanced capability management. Regulatory barriers that prevented industries or industrial processes being linked together and motivational barriers that wherein firms,

public sector agencies and other relevant local actors had to be willing to co-operate and commit themselves to the process could be overcome by CSM-Hotel ICT that enabled by advanced multidiscipline and intercompany co-operation network.

There were problems faced by EIP that might be also faced by CSM-Hotel; for example, the over dependencies among the members. This problem could create inflexibility that might lead to inertia and a lack of innovation within the organization. However, this problem could be turned to be an advantage. It could create connections between the members that might fix infrastructure and lessen the chance of members' movement which benefited for long term collaboration.

Trust was a key factor in EIP. To prevent problems raised due to this factor, CSM-Hotel offered a framework within ICT domain that combined all services and presented all capabilities and restrictions. It made CSM-Hotel that consisted of many firms looked like one entity. The proposal of CSM-Hotel gave an example about a request from a customer to have a service or combination of services. The members of CSM-Hotel together tried to satisfy the requested services. Then, the firm in CSM-Hotel that could handle the service was determined.

Current eco-factories were mostly monocultures that hosting rigid case-optimized processes. Consequently, change costs were high. They also lacked economy of scale in at least one of the competitive dimensions knowledge, capabilities, competences, and/or cooperation. To eliminate these rigidities, CSM-Hotel was stated as a role based relaxed stability structure allowing constant change and effectively addressing all competitive sustainability dimensions.

Kalundborg in Denmark was stated by Gibbs (2003) as a constant reference of EIP and a working model in the literature. However, it was difficult to get established by new policy - led initiatives based upon the interchange of wastes and energy. It could be solved by CSM-Hotel since CSM-Hotel was a platform that identical to other platforms and also possible to synchronize to each other in real time. CSM-Hotel consisted of five local platforms and one connecting virtual platform.

Moreover, according to Chertow (2007) two fundamental conclusions had gained acceptance concerning the Kalundborg case. First, rather than resulting from planning or a multi stakeholder process the Kalundborg symbiosis emerged from self-organization or in other words key types of mixed industrial ecosystems are self-organizing. This was what CSM-Hotel had in its paradigms: self-organization systems and autonomous-holonic. Second, once a revelation was made, a coordinative function was found to be helpful in organizing more exchanges and moving them forward. This was also owned by CSM-Hotel with cooperation-holonic paradigm.

4.3.2 The benefits of becoming CSM-Hotel partners

CSM-Hotel would gain all benefits gained by EIP since an eco-industry area would be a part of CSM-Hotel and also considering above explanation in section 4.3.1. Those benefits would further go to the partners of CSM-Hotel. Moreover, barriers, problems, and weaknesses faced by EIP could be overcome and eliminated by CSM-Hotel which gave positive indicators that development and later operations of CSM-Hotel could be expected to succeed and gave benefits to the partners.

Other benefits that a partner could get from CSM-Hotel were added as follows. Instead of trying to get in into an EIP which needed to be geographically located in the same location where an EIP lay, CSM-Hotel offered flexibility to still locate where their factories lay and got networked to a platform virtually.

A very advanced ICT owned by CSM-Hotel made the partners possible to quickly get updated what was going on in the network and the best practices experienced by CSM-Hotel to be anticipated and adopted respectively by the partners.

The core of the consortium was led by universities that were independent and might be free from business interest. These facts could be assumed and expected to be able to create conducive environment for fairness and trust in CSM-Hotel. Moreover, universities or research institutes were capable to formulate and produce theories to be adopted by the partners.

Any collaboration attempts that were temporarily set up between firms usually consumed time and money significantly, for instance, a temporary collaborative work in product development phase. It could be reduced or even eliminated using established infrastructure, procedures, and framework owned by CSM-Hotel.

Collaboration was believed to be able to breed innovation that gave competitive advantages. Its result was even better compared to the sum of innovative work done by firms individually. CSM-Hotel was a collaborative organization, thus innovation could be created. Moreover, CSM-Hotel proposal stated that wide support services, both locally and globally, were provided, thus individual companies (the partners) could concentrate on improving their processes and CSM-Hotel concentrated on improving the context, its processes and services.

5 Managerial Implication

This chapter discusses the findings derived from previous chapter. This chapter has two sections. Section 5.1 describes the development of CSM-Hotel towards sustainable management. Section 5.2 describes factors that are needed to be considered by managers to build robust and long-lasting collaborations.

5.1 Towards sustainable management

The managers of CSM-Hotel need to consider some factors to accommodate their needs in sustainable way or may be called as applying sustainable management. Therefore, their aim to achieve a condition to where a CSM-hotel becomes a sustainable organization can be achieved.

The first concern is about level of integrations between partners that have to be improved to promote sustainable management. The managers can achieve it by putting efforts to increase awareness of interdependence of various stakeholders within the CSM-Hotel. For example, by implementing product development, applying new technologies. Moreover, the managers should establish a holistic view on production process and products within the CSM-Hotel. Consequently, unsustainable processes can be minimized.

The second concern is related to managers' mindset on sustainability. Behaviour of managers for only wait and see any activity or process inside the network is needed to be avoided. They have to be innovative or think and act one or even few steps ahead among their competitors for achieving sustainability in all facets within the CSM-Hotel since, particularly, current regulations and markets put more pressures on sustainable products. Thus, soon sustainability will absolutely be one of the most important requirements in the market. Furthermore, the managers are needed to consider of sustainability along with product life cycle and take more responsibilities on impacts created on life cycle stages rather than in production. Consequently, the responsibility of the CSM-Hotel activities will not only at production site but also the whole product chain. This is supported by the argument of Jorgensen (2007) who said that sustainable management system that

was built on a balance between economy, environment and social responsibilities will form a basis change towards sustainability. Thus, moving towards more sustainable management system needs to consider business strategy of life cycle management.

The third concern is about applying continuous review. Therefore, managers need to review all CSM-Hotel's structure and processes to determine any impact caused by the structure and processes. The reviews have to include business, environmental and social dimensions which later will be adapted to ensure the broadest possible positive impacts within these three dimensions. Similarly, Daub and Ergenzinger (2005) viewed that by involving not only shareholders but all stakeholder groups; for example, employees, customers, investors, suppliers and government, will achieve sustainability. This was reasoned by these parties under sustainable management philosophy are able to influence development of a business of permanent dialogue. However, it should be noted that any effort of one dimension will not create a harmful impact to others thus everything is needed to be synergized. However, necessarily to add that this is not a voluntary service whenever economic dimension has fulfilled.

The fourth concern is relating to quality. Managers must hold a perception that the world is relatively full rather than empty. Consequently, as stated by Gladwin et al. (1995), an organizational incentive system will emphasize quality rather than quantity. Here, CSM-Hotel cannot be grown indefinitely, but can be developed indefinitely thus a qualitative improvement is needed to be embedded in all processes.

The last concern is support tools. It was stated by Gladwin et al. (1995) that practical decision-support tools are needed to systematically include sustainability criteria in order to evaluate design and selection of product, processes and projects. For examples, design for environment, life-cycle analysis, full-cost pricing and industrial ecology models. Furthermore, any tool that focuses on process objectives (e.g., pollution reduction or continuous improvement) is needed to be

transformed into tools that focus on outcome objectives (e.g., assuring ecosystem and socio-system health, integrity).

5.2 Factors to consider in the proposed framework

It has been stated that a CSM-Hotel is a form of collaborative organization. Thus there are several factors that might be beneficial to be considered by managers. These factors are developed from Hawkins & Little (2011) who proposes a framework that is suited to be applied to any form of collaborative organization.

The first factor is leadership to ensure that the collaboration will work well in robust and sustainable manners. The managers should have skills, capabilities and knowledge of collaborative organization, especially people, who fill managerial positional level. However, it should be noted that managers who gain success to manage a traditional business, are not automatically able to handle a collaborative organization. It is because the key is not a position or power of managers but abilities to influence.

The second factor is collaborative development. A CSM-Hotel needs to look beyond traditional evaluation criteria, whether developing and marketing a collaborative approach or seeking suitable collaborative partners. There are some criteria suggested by Hawkins & Little (2011) that include attributes or how their business operates, ability or their experience capability to work collaboratively, and attitude or an embedded culture/ethos of collaboration. Moreover, considering others alongside themselves may be a way to identify potential partners. However, the collaborative business model cannot be solely dependent on behavioural training, teambuilding, or individual skills. The concept must be embedded in the governance and processes of an organization. Every business aspect also needs to be reinforced by applying concept through policy, process, and systems.

The third factor needs to be considered is managing conflicts of behavior and policy since, nevertheless, there is possibility to raise such conflicts in any collaboration. Similarly, Hawkinds & Little (2011) stated that a common drawback comes when euphoria dissipated and people have to get down delivering

outcomes, meeting internal processes and performance measures. At this point, partners of a CSM-Hotel may revert to business as usual. Consequently, the proposed framework can be expected to act as a bridge between cultures and has ability to form more robust partnership or alliance so it will reduce confusion, provide confidence of participants and create a foundation of innovation.

6 Conclusion

This chapter summarizes and concludes this thesis.

The chapter of analysis decided a framework of sustainability from Azapagic & Perdan (2000) to be applied in a CSM-Hotel, which has three dimensions: environmental, economic and social dimensions. By reviewing and analyzing the proposal of CSM-Hotel, there is only environmental dimension that is related to a CSM-Hotel. The proposal addressed extensively indicators of environmental dimension and also provided several facts of what have been achieved by the members of consortium and also what are intended to achieve in the future. Economic dimension is not addressed convincingly, only based on assumptions that CSM-Hotel might be related to this dimension because of its paradigm of CSM and the use of words "sustainable employment". Furthermore, social dimension is not explained or even mentioned in the proposal, it can be therefore concluded that CSM-Hotel does not relate to social dimension.

Literature review concluded that only one framework that can be applied to a CSM-Hotel. This framework is proposed by Camadinha-Matos & Afsarmanesh (2007) who stated that a collaborative organization has two perspectives: endogenous or internal and exogenous or external. This framework is able to accommodate any paradigm in CSM-Hotel; for example, holonic, self-organizing systems and also sustainability. Therefore, this framework is believed will be applicable to a CSM-Hotel to support its sustainability and named as Sustainable Holonic Collaborative Management Model. The name aims to reflect the content of the model that sustained of three dimensions of sustainability development. Holonic presents the core of operation of a CSM-Hotel that is sourced from holonic paradigm while collaborative shows a collaborative way on organizing a CSM-Hotel.

Nevertheless, a CSM-Hotel has an eco-industry area, sustainable technology service providers, Science Park, University, and eco-city that, therefore, can be assumed that a CSM-Hotel gives benefits to a partner. The benefits are competitive

advantages, environmental improvement and innovation. Furthermore, to aforementioned benefits, a CSM-Hotel can overcome problems faced by EIPs so there are benefits gained when the CSM-Hotel partners are able to solve the problems. For example, trust, lack economy of scale, learning process, self-organizing, coordination, geographic location, and several barriers (e.g., technical, economic, regulatory and motivational barriers).

7 Further Research

Since this thesis conducted only within three and half months the deepest analyses can be researched further in the future. In-depth understanding from literature review provides future thoughts to conduct future study; for example, knowledge of sustainability, collaboration framework and EIPs will give better comparison to a CSM-Hotel. Consequently, having a separate analysis of each area will give a deeper understanding on a CSM-Hotel which may also give a clear perspective that how those areas are interrelated.

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