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Adoption of transport related innovations in the craft industry: Key theoretical approaches

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Summary:

Electrical utility vehicles and mobile management systems represents to important innovations in the crafts industry. Together they may contribute significantly to reduce Co^2-emissions from craftsmen transport. This report reviews six theoretical approaches that may be used in investigations of such innovations among small craft enterprises. Recommendations for further work in the Crafttrans project is given.

Sammendrag:

Elektriske varebiler og kommunikasjons-systemer for å effektivisere kjøreruter representerer to viktige innovasjoner innenfor håndverkerbransjen. Disse kan vise seg å ha stor betydning for å redusere utslipp av Co^2 fra håndverkertransporter. Rapporten gjennomgår seks sentrale teoretiske forståelser som kan anvendes i analyser av denne typen innovasjoner. Anbefalinger for kommende analyser i Crafttrans prosjektet blir fremlagt.

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Preface

The craft industry involves a large number of small enterprises offering different professional services for customers within geographic regions (e.g., carpenters, electricians, metal workers). In contrast to manufacturing industry, work conducted in the craft industry is less automated and more based on professional traditions and standards. Despite their significant numbers and transport requirements, little research has so far been conducted to map their transport activities or to mitigate on their transport related environmental impact. The CRAFTTRANS project has as its ambition to fill this research gap and explore how the craft industry can move towards more efficient and sustainable transportation. This report is based on work conducted in work package 1, and provide a general overview of the relevant theory and literature relating to the implementation and adoption of sustainably oriented innovations in small- and medium-sized enterprises (SMEs). Based on this review, relevant theoretical approaches for subsequent work packages is suggested.

The CRAFTTRANS project is funded by the Norwegian Research Council (Smarttrans program), the Norwegian Public Roads Administration, Municipality of Oslo (Bymiljøetaten), and RBI Norway. The project is managed by the Institute of Transport Economics. Scientific partners include the Norwegian University of Science and Technology, the University of Oxford (UK) and Statistics Norway (SSB).

Oslo, June 2014
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Content

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Summary:

Adoption of transport related innovations in the craft industry: Key theoretical approaches

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Innovations are increasingly seen as important to initiate and strengthen transitions towards more sustainable transport in small -and medium sized enterprises (SME). Small enterprises in the craft industry have so far lagged behind larger enterprises when it comes to implementation of innovations that can improve sustainability and efficiency of craftsmen transportation. Rapid development of mobile communication technologies and software, and access to a wider range of electric utility cars, provide opportunities for developing more sustainable and efficient craft enterprises.

The craft industry involves a large number of employees in Norway, which undertake a significant number of trips in urban and sub-urban areas. Figures from Statistics Norway show that the number of vans and small lorries driven by craftsmen is growing, contributing to increased congestions and emissions. Policy measures to improve the sustainability of urban transport also need to consider mobile workers like field service workers and craftsmen.

During the past few years new technologies have been introduced that can increase the efficiency and sustainability of craftsmen transportation. Firstly, developments involve ICT-based tools to improve the coordination of assignments, order management systems, and route optimization to limit time spent on the road. These technologies have so far not been pursued in any significant number in the craft industry. Secondly, sales of electric vehicles have increased rapidly in recent years, although so far primarily in the private market. However, increasing number of businesses start to implement electric vehicles in their car fleet, but for the most part for person transport.

In the CRAFTTRANS project the potential impact of these two innovations is investigated, based on triangulation of quantitative and qualitative data sources.

An investigation of the adoption of these innovations in the craft industry needs to rely on a given conceptual and theoretical foundation. For the purpose of the forthcoming work, this report seeks to clarify key concepts, and six theoretical approaches drawn from the literature describing adoption of innovation in organizations are reviewed. This includes traditional diffusion theories, psychological adoption theories, social constructivist theories, organizational contingency theories, institutional and network theories, and transition management theories (see Table I). Within each of these broad theoretical approaches, some selected theories are exposed.

Table I: Overview of theoretical approaches and theories examined in the report.

Approach	Theories	Contributors*
Diffusion of innovation	Traditional DOI	Rogers et al, 1971, 1995
	Organizational DOI	Frambach et al, 2002
Psychological	Theory of reasoned action	Fishbein & Ajzen, 1980
	Techology acceptance model	Davis, 1989
	Unified theory of acceptance	Venkatesh et al, 2003
Social constructivist	Community of practice	Lave & Wenger, 1991
	Cultural framing of technology	Orlikowski & Gash, 1994
	Domestication theory	Silverstone et al, 1992
Contingency	Dual-core theory	Daft, 1982
	Ambidextrous theory	Duncan, 1976
	Environmental change	Damanpour et al, 1989
Institutional & Network	Regional Innovation systems	Asheim et al, 2007
	Social network theories	Lin, 2001
Transition management	The multilevel perspective	Geels, 2002

** Examples*

A brief review of current research on *Electric Utility Vehicles* (EUVs) indicate that several of the approaches are exploited in the transport literature. There are, however, few (if any) research conducted on adoption of *Mobile Media Applications* (MMAs) among small craft enterprises.

The various theories comes from different scientific disciplines, they focus on different elements and aspects within the adoption process, and they also tend to rely on different methodological strategies. Yet, the theories are not isolated, and more recent approaches usually "borrow" heavily from the earlier approaches.

For the purpose of this project, a combination of theoretical approaches are recommended. For the forthcoming survey exploring interest for adopting EUVs among managers in the craft industry, organizational diffusion theory and psychological adoption theory is a useful point of departure. For the case studies investigating the uptake of EUVs and MMAs a social constructivist approach, such as cultural framing or domestication theory, will be more relevant.

1 Introduction

The CRAFTTRANS project is motivated by a concern for the problems caused by traffic congestion and accessibility upon craftsmen and other groups that are dependent on transporting personnel, equipment, and material to carry out their work. Traffic volumes in and around the major cities in Norway is increasing. Increased congestion and reduced access to parking facilities have severe negative impacts on delays, deliverability, and costs for industry and commerce. For mobile workers who are reliant on car transportation, these problems often cause stress and job dissatisfaction (Denstadli et al., 2008). Customers also suffer when assignments are not done in time. Despite increased attention to the importance of organizing for smarter and more efficient business transports, most recently in the National Transport Plan (NTP), little empirical research has been conducted on craftsmen's travel activities.

During the past few years new technologies have been introduced that can increase the efficiency and sustainability of craftsmen transportation. Firstly, developments involve *ICT-based tools* to improve the coordination of assignments, order management systems, and route optimization to limit time spent on the road. These technologies have so far not been pursued in any significant number in the craft industry. Secondly, sales of *electric vehicles* have increased rapidly in recent years, although so far primarily in the private market. However, increasing number of businesses start to implement electric vehicles in their car fleet, but for the most part for person transport. Both these technologies can be expected to have an significant impact on how the craft enterprises perform their work tasks, and organize their transport activities.

Our aim in the first part of the project has been to establish an overview of theories that may be applied to study adoption of these innovations in craft enterprises. Based on this review, recommendations for the work in the following WPs are given. The main body of this document is an outline of the key theoretical perspectives that may inform our subsequent work. This includes: (i) Diffusion of innovation; (ii) psychological adoption theories; (iii) social practice theories; (iv) contingency theories; (v) institutional theories; and (vi) transition theories.

Note that this is not a comprehensive list of approaches, but a selection based on relevancy for the project and general exposure in the literature.[1] Neither is this a detailed descriptions of these theories, but an introduction to its core ideas and premises. Relevancy is determined by the focus of the project. Thus, before presenting the theories, we briefly introduce the key objectives of CRAFTTRANS, as well as the key concepts applied.

[1] This review has been based on searches of the following interdisciplinary databases of peer-reviewed articles: *ISIS, ScienceDirect* and *SpringerLink*.

1.1 The CRAFTTRANS project

The point of departure for the CRAFTTRANS project is in investigating how changes towards more sustainable modes of transport can be achieved among craftsmen and related groups of professionals dependent on transport personnel, equipment, and material.

During the past few years, new technologies introduced to increase the efficiency and sustainability of craftsmen transportation have involved *ICT-based tools* (improving the coordination of assignments, order management systems, and route optimization to limit time spent on the road). With the rapid growth in mobile networks and technologies these tools are becoming highly relevant for the SME market, yet so far have not been pursued in any significant number in the crafts industry. In addition, sales of *electric utility vehicles* (EUVs) have increased greatly, although primarily in the private market. In 2013, Norway had the largest number of electric cars per inhabitant in the world (Figenbaum and Kolbenstvedt 2013). The CRAFTTRANS project investigates possibilities for SME craft enterprises[2] adopting EUVs and an ICT-based fleet management system, and for developing more sustainable transport behavior. SME craft enterprises flourish in service-based economies such as the one in Norway, and according to national statistics more than 95 percent are SMEs (Grimsby, Grünfeld and Jakobsen 1999).

The rapid growth in electro-mobility in the consumer market is reflected in a growing number of scientific studies of consumer adoption patterns (Dijk and Yarime 2010; Egube and Long 2012; Nilsson, Hillman and Magnusson 2012; Schuitema et al. 2013). So far, however, there have been no equivalent works addressing the adoption of EUVs within the professional craft sector. Despite a considerable number of mobile professionals, there has not been much study or investigation of the overall mobility patterns of craftsmen, or of the possibilities for mitigating fossil-based transport. Compared to the number of studies focusing on "business professionals", there have been very few works analyzing mobility, innovation or ICT within the crafts industry.[3]

Yet, a change in the behavior of SMEs could contribute significantly to the development of a more sustainable transport system. Although hard to specify in detail, the volumes of transport from small crafts industries in urban areas are undoubtedly significant. One aim of the CRAFTTRANS project is to investigate how increased uptake and use of new transport-related technologies might facilitate more efficient and sustainable transport for Norwegian craftsmen.

The project focuses on craftsmen operating in a limited number of businesses within (and around) Oslo and Trondheim. The research is therefore centred around craft workers operating within two of the largest cities in Norway.

The following key questions are central throughout:

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[2] The crafts industry, as understood in this project, comprises a large number of small enterprises offering different professional services to customers within geographic regions (e.g., carpenters, electricians, metal workers or information technicians serving customers in the greater Oslo area). In contrast to manufacturing industry, work conducted in the crafts industry is less automated and more based on professional traditions and standards. A craftsman (Norwegian: håndverker) may be defined as someone who works in a craft enterprise and conducts the core activity.

[3] For some exceptions, however, see Luff and Heath (1998) and Ling and Julsrud (2005).

- What are the factors – internal and external – affecting SMEs' adoption of sustainable transport technologies?
- What are the key organizational processes related to adoption of sustainable transport technologies (EUVs and MMAs) in SMEs?
- In what way does implementation and use of new transport technologies (EUVs and MMA) affect work practices within the SME?
- How can a transition toward more sustainable transport technologies across multiple SMEs be enhanced and supported through governmental initiatives and policies?

Work is organized as a series of interconnected packages. Empirical work includes: registration of small vans in Oslo/Akershus passing through toll stations around the city centre in Oslo – giving an estimate of the volumes of transport generated by SMEs (wp 2); a survey of SME managers in the crafts industry in Oslo and Akershus (wp 3); and a series of case studies of SME adoption of EUVs and MMA in Oslo and Trondheim (wp 4). This review has been conducted as part of wp 1, and it addresses, in particular, the need for theoretical concepts and frameworks to be used in wp 3 and 4.

2 Adoption of innovations in SMEs: Key concepts

Supporting innovation in SMEs remains at the heart of policy initiatives stimulating economic development at the local, regional, national, and European levels (OECD 2004). Despite the scientific literature being rich in both theoretical and empirical contributions, there are very few clear-cut definitions of key concepts such as innovation, diffusion, implementation, and adoption. We therefore describe how we understand these terms.

2.1 Innovations and inventions

In general, *innovation* can be defined as the implementation of a new or significantly improved product, process marketing method or organizational method in business practice, workplace organizations or external relations (OECD, 2005; Fagerberg, 2005). Consistent with this definition, there are different types of innovation. A distinction may be drawn between *product innovation*, describing the creation of new products or technologies, and *process innovation*, which refers to improvements in the manufacturing of (new) products. *Organizational process innovation* is often seen as a particular subtype of process innovation, indicating new ways of organizing work (Edquist, Hommen and McKelvey 2001). Clearly, all three innovation types are relevant in studies of transportation (Hyard 2013).

Moreover, innovations can be categorized along a continuum in accordance with how "radical" they are compared to existing technologies. Innovations that are continuous improvements of existing technologies or techniques are described as incremental or marginal, while those that are very different from pre-existing products are labeled "radical" or revolutionary (Freeman and Soete 1997).

While an innovation is the first attempt to put an idea for a new product or process into practice, inventions refer to the first occurrence of that same idea (Fagerberg 2005).

2.2 Sustainable innovations

In a report from the UN World Commission on Environment and Economic Development ("The Brundtland Report"), the concept 'sustainable development' was defined as a *"… development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (WCED 1987). In line with this central definition, the following main measures can be taken: Safeguarding long-term ecological sustainability, satisfying basic human needs, and promoting intra- and intergenerational equity. A sustainable innovation then is a new or significantly improved product, processes or methods, that can be applied to support a societal

development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Accordingly, the organizational concept of *corporate sustainability* can be described as systematic management of corporations designed to balance environmental and social goals – along with economic goals to minimize harm to the natural environment and societies – and to increase benefits (Dyllick and Hockerts 2002). Innovation is a crucial element in developing sustainable corporations, which in turn is the cornerstone of a broader social transformation process.

The relationship between organizational change, innovation, and sustainability has been addressed in several research streams. The term *eco-innovations* describes new or enhanced processes, organizational forms, or products that are beneficial to the environment in that they reduce or prevent negative environmental impacts (Rennings 2000). Similarly, the term *sustainability – oriented innovations* is used to describe organizational development that indicates relative improvement in relation to a prior state or other entity (Klewitz and Hansen 2013).

2.3 Diffusion and adoption

Diffusion is the process by which individuals or firms in a society adopt a new technology or replace an older one with a newer one. Adoption is the process through which an individual or other decision-maker unit passes from first knowledge of an innovation to forming an attitude to it, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of the decision (Rogers, 1995: 21).

From a sociological point of view, Rogers' stage-based model of diffusion has been particularly influential. In an organizational context, diffusion relates to a managerial decision whether or not to adopt a new given innovation. More often, however, this is a decision about adopting a product earlier or later within a given period of time. There are benefits and risks related to being an "early adopter" as well as being a "laggard". Early adopters may implement incomplete technologies or face critical mass problems, while late adopters run the risk of being outdistanced by their forerunners. Historically, adoption of innovations such as of cars, computers or mobile phones has followed an S-shaped curve, where adoption speeds up after a slow start and slows down when saturation level is reached. Saturation tends to be reached on about 90 percent (Hall 2005). Recently, more epidemic models have been applied in economic and sociological studies, suggesting more radical and unpredictable patterns of adoption (Gladwell 2000; Watts 2004). In the case of technical innovation in SMEs, this process consists of several episodes that are recursively rather than sequentially organized, including innovation, diffusion, and adoption.

There is a crucial analytical distinction between the *generation* of an innovation, closely related to the invention process, and the *adoption* of a pre-existing innovation (Damanpour and Wischnevsky 2006). Generation of innovation results in an outcome – a product, service or technology that is at least new to an organizational population. The adoption of innovations, on the other hand, is the assimilation of a product, service or technology new to the adopting organization. Existing research on innovation in organizations often has not distinguished between generation and adoption processes, and in fact has named both as innovation processes. As argued

by (Damanpour and Wischnevsky 2006), the processes of innovation generation and adoption differ considerably. The *generation process* includes recognition of opportunity, research, design, commercial development, and marketing and distribution. It covers all efforts and activities aimed at creating new ideas and getting them to work. As a whole, the generation process produces the innovation and supplies it for transfer to, and use by, other organizations. The *adoption process* – which is the focus of this paper – is conceived to include two main sub-processes: *initiation and implementation*. This involves all events and actions that pertain to modifying the innovation and the adopting organization, using the innovation initially and continuing to use it until it becomes a routine feature of the organization.

2.4 Small- and medium-sized enterprises (SMEs)

Different countries have different criteria for classifying enterprises in general and SMEs in particular, and a set of different variables may be included in the decision as to whether a company should be defined as an SME (turnover, income, number of employees, etc.). In a Norwegian context, number of employees is the most commonly used classifying criterion involving enterprises of between 20 and 100 employees (Grimsby, Grünfeld and Jakobsen 1999). A "microenterprise" is usually applied to a company of fewer than 20 employees.

3 Theoretical approaches

As previously mentioned, the term 'organizational innovations' refers to the creation or adoption of an idea new to an organization (Damanpour and Wischnevsky 2006; Lam 2005). The focus for the CRAFTTRANS project is adoption of *technical innovations* within groups of SMEs in the crafts industry. Yet, technical innovation can also involve *organizational innovation* and change in "how things are done" within the SMEs. Moreover, the project emphasises *adoption of innovations* rather than generation of innovations, and this is reflected in the theories described.

The number of works emphasizing adoption of innovations at the level of the organization is huge and fragmented (Edwards, Delbridge and Munday 2005; Lam 2005), and theories have their roots in different disciplines and professions. In many ways, theoretical approaches represent conceptual frameworks highlighting different aspects of the characteristics of organizations, their environments or the behavior of their managers and employees.

Here, we present theories on traditional diffusion, psychological adoption, social practice, organizational contingency, institutional/network and transition management. Our review somehow moves from a focus on the individual towards a focus on the group, the organization, and the larger institutional environment. Note that we use the term 'approaches' when describing more overarching fields, whereas 'theories' is used to denote more detailed analytical frameworks.

3.1 Diffusion of innovation approach

Traditional innovation theory is concerned with how new ideas spread in society and what it is that influences people to "adopt" innovation (Rogers and Schoemaker 1971; Rogers 1995). The approach has been influential across several disciplines, and there are several extended versions of the traditional diffusion theory. Rogers also made amendments to the traditional theory in later works, including key elements from social network and social constructivists approaches (Rogers and Kincaid 1981).

3.1.1 Traditional diffusion theory

Rogers' diffusion of innovation theory (DOI) is particularly important because it builds on a long series of studies in rural sociology. According to this theory, diffusion is about how an innovation is communicated through certain channels over time to the members of a social system. The point of departure is the S-shaped diffusion curve, and the adopters are classified within five ideal typical groups depending on where they belong in the adoption curve. "Innovators" represent only 2-3 percent of users followed by "early adopters", "early majority", "late majority" and "laggards".

The focus of the theory is not simply to classify users, but also to understand how ideas spread in social systems, and what factors are involved in the process (see Figure 1 in Rogers and Schoemaker, 1971: 158). Rogers emphasizes five key factors related to the innovation itself and that are critical for adoption:

1. Relative advantage: the degree to which the innovation is perceived as better than the existing products or systems.
2. Conformity: the extent to which the solution can be considered consistent with existing values, norms, and attitudes.
3. Complexity: the degree to which the innovation is perceived as difficult to understand.
4. Testability: the extent to which it is possible for people to test out innovation on a small scale.
5. Observability: the extent to which the results of an innovation are visible to others (the more visible, the more likely to be adopted).

The adoption rate is also affected by the type of decision-making in the enterprise, the available communication channels (face-to-face, mediated), qualities of the social system (norms, density, cultures, etc.), as well as reward systems for involved change agents. Figure 1 provides an overview of key factors affecting rate of adoption according to DOI.

The distribution process is largely driven through informal and formal communication networks (Rogers and Kincaid 1981). Particularly important for these processes are "opinion leaders" and "change agents".

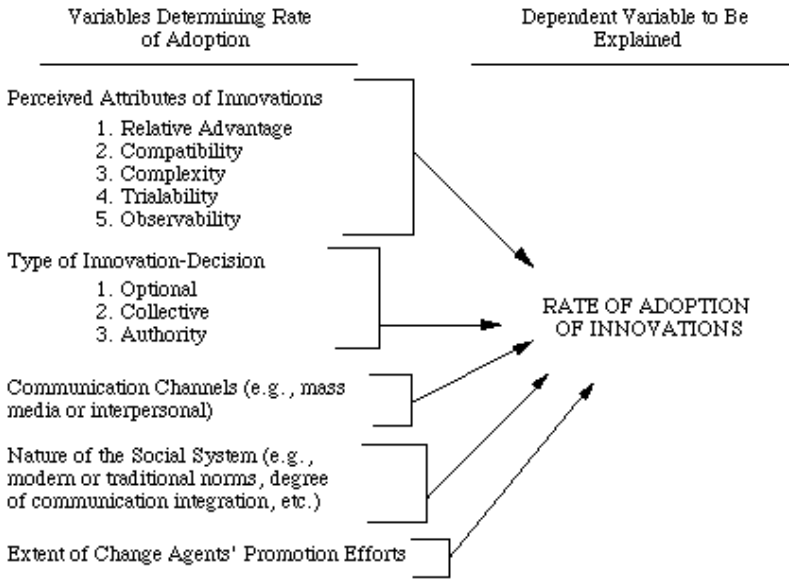


Figure 1: Variables that influence an innovation's rate of adoption (Rogers et al., 1971)

Opinion leaders are located within social networks and have special abilities and opportunities to affect others. Change agents are representatives of companies or governments that have special interests in accelerating the innovation within a system.

The "diffusion of innovations" model is based on a set of implicit assumptions: namely, that the innovation is an object, that innovations are the best policy, that the user is a passive agent in the process, and that the process remains linear and static (Edwards, Delbridge and Munday 2005). A basic assumption is also that all

innovations follow more or less the same patterns of diffusion and adoption. The DOI -framework provides an overview of an ideal innovation process, but it leaves little room for explaining why adoption processes operate differently across enterprises, or how the adoption process actually takes place in social systems.[4]

3.1.2 Organizational diffusion theory

Traditional diffusion tends to see innovation as an individual decision making process and it neglect several intra-organizational factors, that have been seen as important in recent studies. Efforts have been made to integrate new variables into the framework of traditional diffusion theory. Frambach and Schillewaert (2002) have proposed a *multilevel framework* that integrates several variables from psychological adoption theory, in particular TAM (see below). The model involves decision making on two levels: one at the organization level and one at the individual level (see Figure 3).

Following the psychological models, their *multilevel (ML) framework* places perceived innovation characteristics in the centre of the model. As for traditional diffusion theory, the aim is to locate factors that are decisive for a decision to adopt an innovation or not.

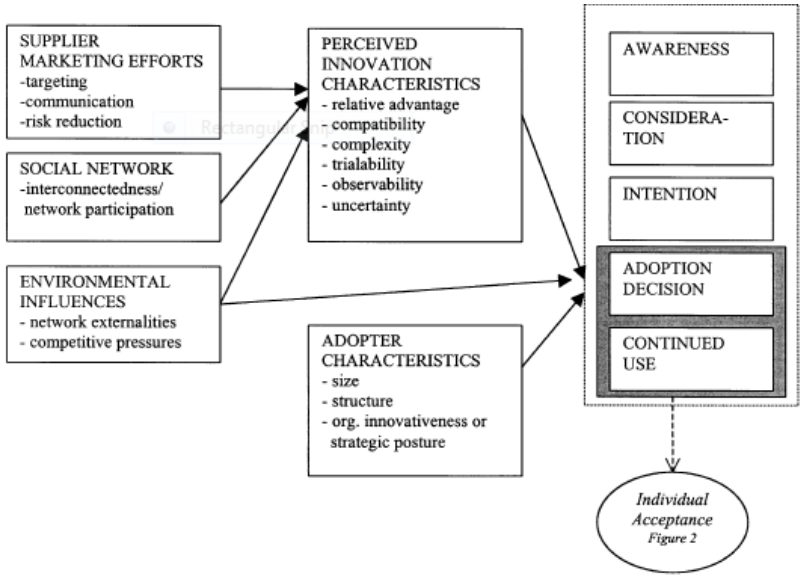


Figure 2: The multilevel framework of organizational innovation adoption (Frambach et al., 2002)

[4] The theory, later revised by Rogers to include more active agents, was influenced by social networks. Rogers may also have spurred later works on "Community of Practice" (Rogers and Kincaid, 1981).

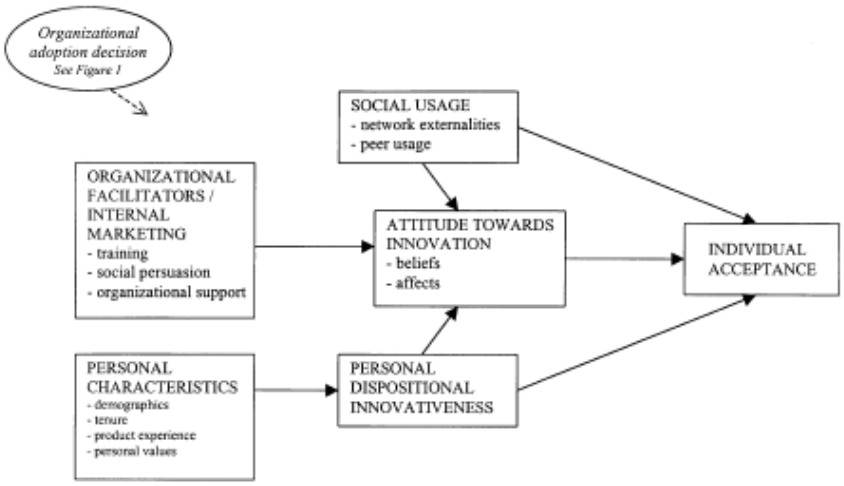


Figure 3: The ML framework of individual innovation adoption (Frambach et al., 2002)

In contrast to traditional DOI, the model involves more psychological factors, integrated in models that also involves indirect effect of factors. The model intends to capture a large number of factors on both individual and organizational level. Yet it is more a constellation of potential factors that may affect adoption in organizations and the interconnections between factors on micro and macro levels is unclear.

3.2 Psychological adoption approach

From a psychological tradition, the adoption of ICT has been analyzed with an emphasis on individual attitudes and social factors in the adoption process. There are different versions of psychological adoption theories, but the majority have emerged out of theory of planned behaviour.

3.2.1 The theory of reasoned actions

The theory of reasoned actions (TRA) originates from social psychology and is a special case of the Theory of Planned Behavior (TPB) (Ajzen 1991). Fishbein and Ajzen (Ajzen and Fishbein 1980; Fishbein and Ajzen 1975) developed TRA to define links between the beliefs, attitudes, norms, intentions, and behavior of individuals. Their theory assumes that a person's behavior is determined by his/her behavioral intention to perform it, while intentions are determined by attitudes and perceived subjective norms towards the behavior. The subjective norm refers to "… the person's perception that most people who are important to him think he should or should not perform the behaviour in question" (Fishbein and Ajzen, 1975: 302).

Ajzen and Fishbein's (1980) work emphasizes the prediction and understanding of human behavior as helpful in solving applied problems and making policy decisions. They state that TRA is applicable, for example, when studying consumer behavior, women's occupational orientations, or family planning behaviors. In these studies, TRA was used to compare with "technology acceptance models" (Davis et al., 1989, see below), or in combination with DOI (Karahanna, Straub and Chervany 1999). Karahanna et al. (1999) have examined users' pre- and post-adoption beliefs and attitudes by combining aspects of TRA and DOI.

3.2.2 Technology acceptance models (TAM)

One of the most popular theories when studying the implementation and adoption of ICT in organizations is the Technology Acceptance Model (TAM) (Davis 1989; Korpelainen 2011). This theory aims to predict and explain ICT usage behavior, that is, what it is that causes potential adopters to accept or reject the use of information technology. Theoretically, TAM is a recast of the Theory of Reasoned Action (TRA) adapted to ICT.

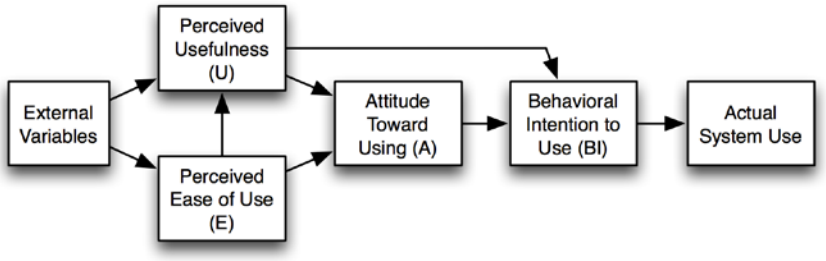


Figure 4: The Technology Acceptance Model (Davis, 1989)

In TAM, two theoretical constructs, *perceived usefulness* and *perceived ease of use*, are the fundamental determinants of system use, and they predict attitudes to system use. Perceived usefulness is "… the degree to which a person believes that using a particular system would enhance his or her job performance", while perceived ease of use is "… the degree to which a person believes that using a particular system would be free from effort" (Davis, 1989: 320).

In later works, Venkatesh and Davis (Venkatesh et al. 2003) extended the original TAM model when explaining perceived usefulness and usage intentions in terms of social influence and cognitive instrumental processes.

3.2.3 Unified Theory of Acceptance and Use of Technology

Reviewing multiple models explaining ICT usage, including TRA, TAM and DOI, Venkatesh et al. (2003) later developed the Unified Theory of Acceptance and Use of Technology (UTAUT) model, the purpose of which is to explain a user's intentions about using ICT and subsequent user behavior.

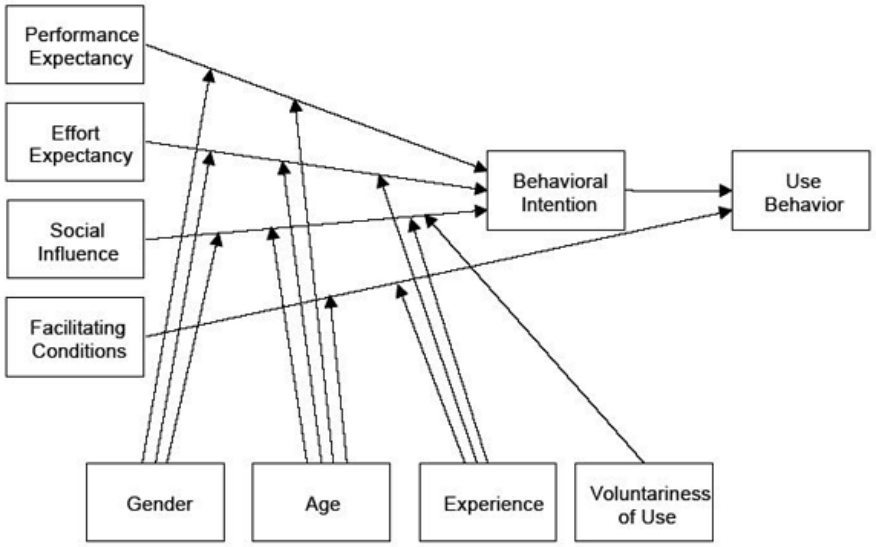


Figure 5: Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003)

The model considers four constructs as direct determinants of user acceptance and usage behavior, namely performance expectancy, effort expectancy, social influence, and facilitating conditions. There are four key moderating variables: gender, age, experience, and voluntariness of use. The authors state that UTAUT provides a tool for managers to assess the likelihood of success of technology introductions and to understand the drivers of acceptance in order to design interventions. The basic idea from TRA, that behavioral intention controls user behavior (and adoption) is intact, although a larger battery of factors is seen as important predictors of intentions.

3.3 Social constructivist approach

Along with the linear models of diffusion and adoption, more user-centric approaches to the adoption of technology have emerged in recent decades. Following these theories, technology does not exist in "pure form" outside a social context, but takes its meaning in social use. From a user-centric approach, the adoption of a new technology or product is not passive consumption, but rather an active process involving development of the meaning of a new artifact used in a given social setting (Bijker and Law 1992; Silverstone and Haddon 1996; Tuomi 2002). While traditional diffusion and adoption approaches take the invention for given, the user-centric approach argues that the user is as important as the inventor in the development of an innovation, because it is the networks of users that give meaning to the technologies when implementing them in their actions and everyday routines. The point of departure for most of these theories are general social constructivism, and in particular the social construction of technology paradigm (Berger and Luckmann 1966; Bijker and Law 1992), Berger). Following this line of thought, an innovation occurs when social practice changes. Here, we draw attention to three distinctive theoretical approaches to the adoption of innovations: *community of practice (COP)*, *domestication theory*, and *cultural framing*.

3.3.1 Community of practice

Following a practice approach, actual use of the new artifacts or tools is important in the process of developing meaning. Social practice consists of reproduced forms of action. Technological artifacts, for instance, often play an important role in the formation of social practice as they externalize aspects of practice and transform parts of it from the mental sphere to the concrete material world. Practices therefore consist of complex networks of tools, concepts, and expectations (Tuomi 2002). Meaning is not something that is grounded on individual decisions or cognitions. In most cases, meaning is created within a community of users communicating and interacting on a regular basis within a given social context. Meaning has its origins in collaborative practical activities, and the community that reproduces specific meanings is labeled as a *community of practice (COP).*

Following Lave and Wenger (Lave and Wenger 1991; Wenger 2000), adoption of new practices – including new technologies – can be analysed as processes of learning within a community of users. In their earliest work, Lave and Wenger (1991) suggested that most of the learning of practitioners occurs in social relationships at the workplace rather than in a classroom setting, a concept known as 'situated learning'. The interactions between novices and experts influence the gradual process by which newcomers create a professional identity. The work was empirically founded on a series of anthropological case studies of how midwives, meat cutters, and tailors learned their skills "on site". In this work, the term COP is loosely defined as people from the same discipline improving their skills by working alongside experts and being involved in increasingly complicated tasks. The journey from being a newcomer to becoming an expert is captured in the concept of 'legitimate peripheral learning', in which newcomers are given opportunities to learn by engaging in simple tasks. Those who eventually master the skills become experts and subsequently assume the responsibility of mentoring other newcomers.

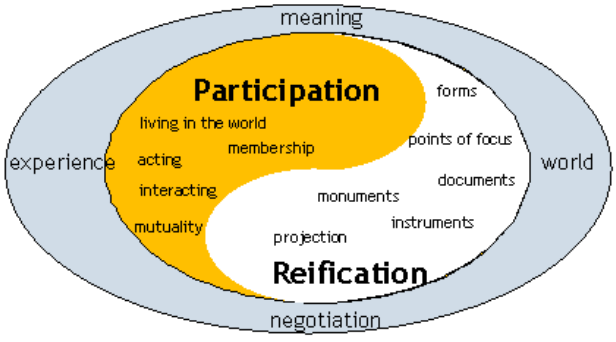


Figure 6: Elements in a Community of Practice (Wenger, 1998)

In subsequent works, Wenger (Wenger 1998) expanded the concept of the COP, putting a stronger focus on socialization and learning and the individual's identity development. His discussion was based on case studies of how medical-claims processing clerks interact with each other and share information for doing routine office work. This approach sees COP as an entity bounded by three interrelated dimensions: mutual engagement, joint enterprise, and a shared repertoire. 'Mutual engagement' is the interaction between individuals that leads to the creation of shared meaning on issues or a problem. 'Joint enterprise' is the process in which people are engaged and work together toward a common goal. Finally, 'shared repertoire' refers to the common resources and jargon that members use to negotiate meaning and facilitate learning within the group (cf. Figure 6).

The COP approach has been influential in studies of knowledge management as well as ICT related adoptions and organizational change. It draws attention to how communities are necessary for developing meaning about a technology and how it is integrated in everyday activities (Hildreth and Kimble 2004; Kimble, Hildreth and Wright 2001; Peansupap 2004). In contrast to the psychological approach, COP is normally investigated through in-depth case studies or comparative studies of a limited number of cases.

3.3.2 Cultural framing of technology

In many cases, organizations perceive technical innovations differently. One way of explaining and analyzing this is in relation to local (organizational) cultures. For Goffman (1974), frames demarcate a set of cultural resources that will be used to create schemata of interpretation that guide her actions. The concept of frames helps to explain why groups of people who share access to the same toolkit of cultural resources might act and perceive the world in different ways.

The term 'cultural frames' is used to explain the cognitive and social resources that individuals use in making sense of new tools. Orlikowski (Orlikowski 2000; Orlikowski and Gash 1994) and others have shown that interaction with a new technology marks an occasion in which there is much ambiguity and uncertainty, and on these occasions people will usually construct *frames* to help guide their action. The specific concept of a "technological frame", arising from a paper by Orlikowski and Gash (1994: 178), refers to instances in which people use cultural resources to make sense "… not only of the nature and role of the technology itself, but the specific conditions, applications and consequences of that technology in particular contexts".

The authors suggest that different groups within the same broad organizational culture may construct radically different frames to interpret the technology; their departmental membership, occupational orientation, and technical knowledge base influence their selection of cultural resources. Because technologies are interpretatively flexible – meaning is attributed to them as opposed to existing within them – members from different groups can indeed construct distinct frames that guide their interpretations of technology's functionality (Orlikowski, 1992).

In a recent study, theories of cultural frames are used to analyse the implementation of software systems in an automotive engineering company (Leonardi 2011). The study shows how cultural frames contributed to "innovation blindness" impeding innovation processes in the organization.

The elaboration of cultural frames, it should be mentioned, is not limited to organizations and their sub-cultures. Cultural frames are usually deeply affected by the rhetoric of marketers of new technologies, as well as politicians and voices in the mass media.

3.3.3 Domestication theory

Emerging from ethnography as well as media studies and sociology, domestication theory (DT) is concerned with how technologies – in particular ICT – are adopted and given meaning in households. DT is concerned with how new technologies find their way, and get their meaning, as a social process. As suggested by the term "domestication", this is seen as a process that has to be given time and effort if it is to succeed.

In contrast to traditional innovation theories (i.e. DOI or TAM), adoption is seen as a process rather than a single event (Haddon 2001). Pre-adoption is captured perceptions of technologies and services in how people imagine the potential role of a given communication technology in their lives and negotiations around, and sometimes resistance to its acquisition. If consumption is taking place, this is followed by the development of an understanding about 'appropriate' usage in the household. In which situations should the technology be used, for what purpose and by whom? When new technologies come into use, these are not obvious questions, according to DT.

Consumer technologies such as radios, mobile phones or computers need to be implemented and integrated within family routines and regularities. How and why the technology should be used is, according to DT (and related ethnographic theories), a product of negotiations among family members. The outcome of these processes is almost always uncertain. The domestication process can be on-going and also re-assessed if new circumstances are involved.

The adoption process may be displayed in four interrelated "steps" where the technology is gradually domesticated in the household (Siverstone, Hirsch and Morley 1992): The first step, *imagination*, is when a new commodity first enters our consciousness. *Appropriation* is the process of possession or ownership of the artifact. This is the point at which an artifact moves from the world of commodity to the owner's possession, it thereby being given significance. *Objectification* is when users ascribe their cognitive values and esthetics to the technology. The technology is given a meaning and a place in users' lives. At this stage the users are involved in making manifest a sense of identity through the use of an object, perhaps to engender a particular effect. In the next stage, the technology is *incorporated* in the process during which artifacts are used in everyday life, and the level of functionality depends on how it is incorporated in everyday life. In the final *conversion process* the product reaches 'taken-for-granted' status to become part of the user's life. This is when the meaning of an object is accepted not just by the user, but also in his or her larger social network.

DT takes account of consumer technologies, but as noted by Silverstone and Haddon may inform discussions of technological change on a wide range of institutional settings (Silverstone and Haddon 1996). More recently, DT has been applied to studies of mobile telephony, drawing attention to social interaction outside the home (Haddon 2001; Ling 2004). Several studies of mobile phone use among friends have made it evident how telephony and related technologies (SMS, Instant Messaging, e-mails) are embedded in social networks. A telephone call is not just a message, but also a symbolic expression strengthening a relationship or a sense of belonging and identity.

3.4 Organizational contingency approach

For the traditional diffusion theories, as well as the psychological approaches, the adoption process is seen as individual decisions. In the social constructivistic approaches the focus shifts towards the family or the small group of acquaintances, but the adopter's work organization is usually not part of the study. For contingency theory (CT), however, the central object of the study is organizations. CT is based on an open system approach where organizations are analysed within the context of

their larger environment of institutions and actors. As in Burns and Stalker's (1961) seminal work, distinctions are made between organizational forms and the more or less dynamic organizational environments. Differences in organizational environments are crucial to understanding differences in organizational structures and processes. In studies of innovations and adoptions, the central approach is that adoption style or processes will be dependent on the organizational environment. Contingency theories come in different versions, with dual-core theory, the ambidextrous theory, and environmental change among the most common.

3.4.1 Dual-core theory

The key argument of dual-core theory is that different parts of the organization are likely to have different adoption processes (Daft, 1982). The theory posits that organizations have both a technical and an administrative core. Innovations can occur in each, but will follow different processes (to succeed). A mechanistic culture is needed in the administrative core, when organizations adapt to changes in goals, policies, strategies, control system, etc. This implies high centralization in decision-making and a "top-down" orientation. On the other hand, an organic structure is needed when changes in organizational products, services, and technologies are needed.

3.4.2 The ambidextrous theory of innovation

This theory (Duncan, 1976) holds a similar argument, although focusing on the two central stages in the adoption process – initiation and implementation. According to the theory, these two processes are in need of different organizational forms. To initiate innovation, high complexity, low formality, and low centralization are necessary; while implementation, on the other hand, needs formalization, lower complexity, and more formal structures.

3.4.3 Environmental change theories

The more recent environmental change theory is an extension and redefinition of former contingency theories. The point of departure is that organizations are open systems influenced by their (business-related) environment. Following Damanpour (1998), organizations operating in different environments will have different conditions for their adoption processes. Two environmental components seen as crucial are: (i) environmental stability and (ii) environmental predictability.

In combination, these variables form four different task environments that are in need of different structures to succeed in their adoption process.

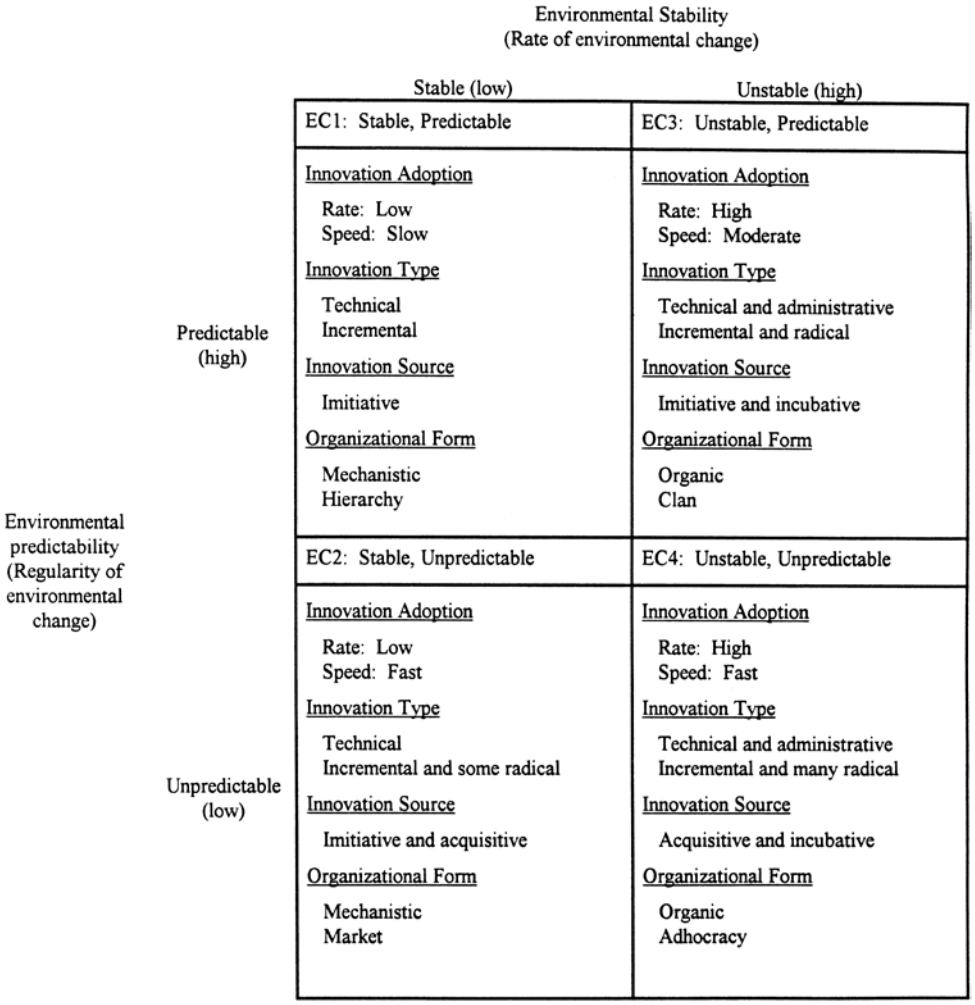


Figure 7: Four environments for innovation (Damanpour et al., 1998)

According to the theoretical framework there are differences related to innovation frequency and type within the different environments. For instance, while technical innovations are important in all four environments, administrative innovations are important only in unstable environments EC3 and EC4. Organizations in EC3 and EC4 place more emphasis on administrative innovation because continuous environmental change requires frequent changes in the structures and systems of these organizations to facilitate adaptation.

3.5 Institutional and network-based approaches

During the early 1990s, there was increasing interest concerning how innovations seemed to grow within certain industrial districts. In regions such as Silicon Valley in the USA or Emilia Romagna in Italia, densely located SMEs seemed to be integrated networks that were able to generate and diffuse innovations efficiently. Awareness of these networks, often involving SMEs, culminated in various theoretical approaches, with the focus shifting from individuals, groups, and organizations to larger regions, networks, and institutions.

3.5.1 Regional innovation systems

From an institutional side, theories of national and regional innovation systems (RIS) have emerged (Asheim, Coenen and Vang 2007; Asheim and Coenen 2005; Bathelt, Malmberg and Maskell 2004; Lundvall and Johnson 1994), according to which locally embedded networks of firms open up for a richer flow of knowledge than distant relationships. Succeeding in transferring tacit knowledge tends to require face-to-face proximity, and, as such, distribution of tacit knowledge is hard to accomplish on a global level. The localized and informal knowledge situated across co-located forms may be labeled "buzz" (Storper and Venables 2004; Storper 2010). Codified knowledge on the other hand tends to flow more readily between geographically distant actors. A RIS is described as the infrastructure supporting innovations within the structure of a region (Asheim and Gertler, 2005). The central idea is that innovations occur within a network of interactions including not just enterprises, but also R&D/universities and governmental institutions. The particular constellation of institutions and firms within a region is obviously of great importance.

Based on the type of industrial actors that operate within regions, Asheim et al. (2005) have suggested two types of knowledge base that require different institutional environments. On the one hand, a *synthetic knowledge base*, where innovation takes place mainly through the application or novel combination of existing knowledge, and, on the other, an *analytic knowledge basis* where scientific knowledge is highly important and where knowledge creation is often based on formal models, codified science, and rational processes. Both types of knowledge are believed to be strongly dependent on co-location and localized learning processes. The institutional approach to innovation and diffusion is based on knowledge flow within geographical regions. As such, attention is primarily on knowledge flows and possibilities for generation of innovations between smaller and larger firms and institutions. Differences in innovative capabilities are to a large extent explained as due to institutional variations.

3.5.2 Social network theories

A parallel stream of theories addresses *structural and personal networks* as central for the innovation process in SMEs. In these theories, the focus is on the particular flow of resources within a diverse set of relationships, rather than on the institutional environment. The impact of business relationships for innovation activities has been well documented in recent decades (Powell and Grodal 2005). Among SMEs in particular, networks of relations seem to be crucial for innovative capabilities since they have limited resources for regular R&D activities. Networks are significant conduits for exposing SMEs to novel sources of ideas, improving their access to inputs and enhancing the transfer of knowledge and technological opportunity (Tomlinson and Fai 2013). In the open innovation system paradigm, network ties are a direct source of innovation activity through both direct and indirect means (Leone 2010).

Both *vertical and horizontal networks* are important for innovation activity. In a survey of 1300 SMEs in Northern England and Scotland related to vertical supply chains, Freel and Harrison (2006) found a positive relationship between a well-developed network with clients and suppliers and product innovations. For process innovations, however, only supplier networks were of importance. More recently, Lasagni (2012) reported that network relations to buyer and suppliers were significantly aiding innovation. Horizontal networks focus on collaboration between SMEs, sometimes

called "co-optation". In a study of 73 bio-technology firms, a positive impact from co-optation networks on innovation capacity was found (Tomlinson et al., ibid.). Others have been unsuccessful in finding evidence of a positive effect from horizontal networks for innovation (DePropis 2002).

Relational networks affect SMEs not only through the *number* of relationships, but also through the *strength* of the relationships, as well as their structural configuration (Ahuja 2000; Krackhardt 1992). The circulation of knowledge is less intense in the periphery of networks than in the central core. In general, stronger ties tend to be more important for tacit knowledge flows, while weaker ties are more important for accessing ideas and information. Thus, the particular combination of weaker and stronger ties is recognized as important for the sharing of knowledge and innovation (Greve and Salaff 2003).

Business relationships are based on multiple interactions and flows of resources and information. Personal relationships, however, tend to increase the flow of information and enhance innovation activities. When personal relationships exist, actors tend to enhance knowledge sharing because of the existence of trust. Lorenzen (2001) distinguishes between dyadic, networked, and social trust. The last mentioned is developed through local information spreading and social learning in industrial clusters. Social trust relies in particular on personal relationships. The importance of informal and personal relationships can be related to Granovetter's (1985) terms of *embeddedness*. According to the embeddedness approach, there is "...a widespread preference for transacting with individuals of known reputation" (Granovetter, 1985: 490). The social network of stronger and weaker relationships is therefore central to the performance and functioning of economic transactions. From a network perspective, trust can work as a type of governance structure of embedded relationships. The term *social capital* is also related to social network analytical approaches, referring to the resources and values represented by a network of actual or potential relations (Lin 2001; Nahapiet and Ghoshal 1998).

In network studies of diffusion, the position and network-based roles are objects of interest. In particular, managers and employees operating as brokers across organizational boundaries are believed to enhance diffusion (Brehm and Scott 2004; Julsrud and Bakke 2007). The term *boundary spanners* is used to describe individuals who are crucial to the exchange of ideas and information across organizational boundaries (Tushman 1977).

3.6 Transition management approach

Transition management theories (TMs) represent an extended and more dynamic understanding, including some of the insights from institutional and network approaches. Similar to the RIS theories, TMs situate the study of innovations within a larger social context.

In a stream of new studies, a more macro-oriented systemic approach to innovation and social change has emerged. Here, we point specifically at theories of transformational change as described by Grin, Rotmans, and Schot (Grin, Rotmans and Schot 2010; Kemp, Avelino and Bressers 2011; Rip and Kemp 1998; Rotmans and Loorbach 2010). A central concern of these researchers is in developing a unifying theoretical framework for understanding innovation and social change based on previous work in sociology, economics, and technology studies. This is work built

on traditional diffusion models, but extends to a more complex model operating on multiple social levels. Focus is a general description of the factors that may contribute to large scale changes in the direction of more sustainable societies.

A starting point for these studies is that the process of change takes place at various systemic levels. The term *niches* refers to small groups of entrepreneurs and early adopters experimenting with innovations at a very early stage. These may (probably) be considered as communities of practice in which meaning is in the process of being developed, but where it still stands out as improvised and experimental. At a higher level, there is the *socio-technical regimes*, where technologies have been segmented into more permanent structures and configurations. The importance of certain types of technology and associated practices is backed-up relationships with other groups and social institutions (regimes). Geels (2002) claims that the regimes include cognitive, regulative, and normative rules. At the highest level there are *landscapes* where technology has become a fundamental part of our understanding of limits of existence. This constitutes the external context in which actors within niches or socio-technical regimes largely have to take for granted.

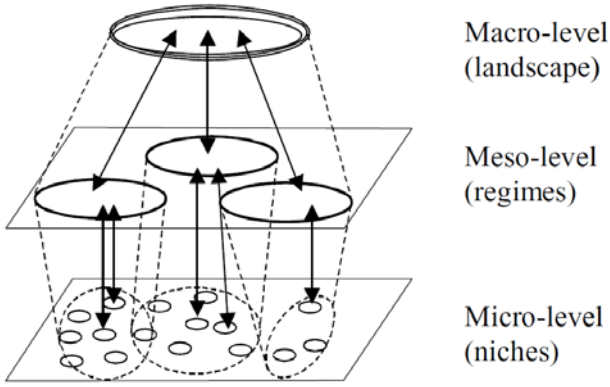
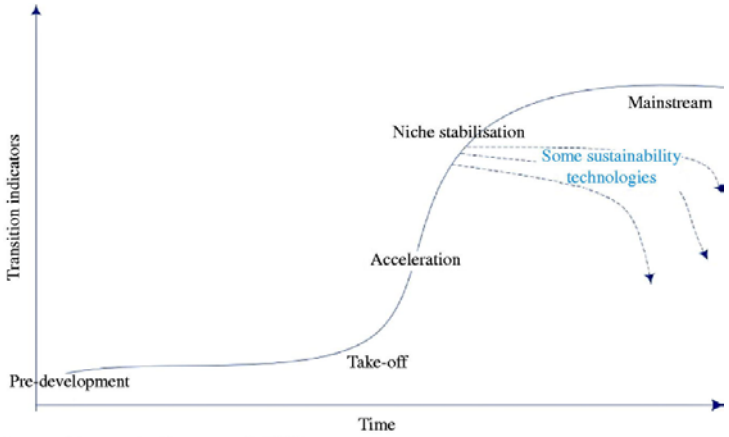


Figure 8: System model on multiple levels (Geels, 2002: 1261)

Technological niches are important because they are usually carriers of new ideas, and because they are outside what is defined in the dominant socio-technical regimes. Niches where actors explore and experiments with new technology can be of different dimensions and often of long duration. In situations where there is turbulence within the technical regimes, however, they can win a bigger foothold, but the degree to which an innovation in a niche winner emerges depends largely on how it fits within the existing regimes and landscapes. Innovations can be in situations where they come into conflict with the existing regimes. Often, however, changes in society's basic assumptions force changes to the current socio-technical regimes and expose them to ideas from technical niches. Some niches come together and form stronger constellations that challenge existing regimes.

In TM theory, changes figure across key stages, not unlike classical diffusion theory. The four highlighted are: (i) an initial phase where the system is intact but the underlying changes in the system take place; (ii) a take-off phase in which a new innovation receives torque and begins to increase in prevalence; (iii) an acceleration phase where structural changes are visible; and (iv) a stabilization phase where a (new) phase equilibrium is established. An idealized innovation process can be described as a classical S-shaped curve (Figure 9). In most situations, however, innovations do not take off as intended and a more negative course is found. According to Rotmans and Lorbach (2010), progress of this kind takes considerable time, often 25 years or more.



Source: After van der Brugge *et al.* (2005)

Figure 9: Emerging transition processes

The basic insight from systemic innovation theory, as outlined by Grin and colleagues, is that evolution takes place as co-evolutions operating at various levels and through different phases. This is non-linear development and it is not possible to predict which direction a given technical innovation will take without the existing social systems (regimes and landscapes) it caters to being taken into account. As with practice theories, it puts strong emphasis on the social interpretations of ideas within small groups.

Although advocates of systemic innovation theory do not think it is possible to foresee changes in complex social systems, it is argued that one can seek to influence the direction and strength of the transitions, especially by encouraging innovative niches. Based on the framework, TM theories emphasize basic management principles that can change the major systems in the direction of new sustainable regimes. In brief, these are: (i) establishing viable venues for innovative niches, (ii) fostering strong niches with capacity to facilitate change, (iii) focusing on variation within different niches, (iv) supporting radical changes, but incremental steps, (v) channeling sufficient resource niches, (vi) encouraging active learning through experimentation, and (vii) being quick to catch up, test, and deploy new technologies and new ideas.

4 Discussion and recommendations

So far, this paper has outlined some of the relevant theoretic positions useful in the forthcoming study of adoption of sustainable technologies among SMEs in the crafts industry. In this last part, we suggest how to proceed in the CRAFTTRANS project.

4.1 Differences and similarities

The theories presented accentuate various levels in the analysis and deal with different areas. Psychologically based approaches, as well as traditional diffusion theories, consider the individual as the central adopter of an innovation, while social constructivist approaches see the adoption mainly as a group process. With the institutional and network-based approaches, as well as the transition management approach, the SME is usually analyzed within the framework of a larger institutional environment. For transition management approaches there is a strong bias on seeing adoption processes within a (longer) historical framework. This is not to say that DOI and TAM do not consider social factors in their models, but in these approaches it is the individual's decision whether to adopt or not that is given precedence.

Moreover, there are methodological differences across the approaches, where psychological, diffusion, and network theories tend to rely on quantitative analysis, while social practice and transition management approaches usually rely more on qualitative evidence. However, the choice of methodological strategies shows that the approaches have their roots in very different disciplines and scientific traditions. Social constructive theories (cultural frame theory, community of practice theory and domestication theory) have their roots in ethnography, phenomenology, and interpretative studies, while psychological approaches are founded on the paradigm of rational choice theory and in economics.

The study of adoption therefore takes on a rather different meaning in the various approaches. Following practice approaches this is studied as a process that involves construction of meaning within a community, possibly including learning and transformed identities. Here, the innovation is an object that takes on its meaning during the adoption process, and as such is open to various interpretations. This contrasts with traditional ideas of diffusion, where the question is whether the adoption is known and defined in advance and then accepted or rejected by a sample of users. In traditional diffusion theory, as well as psychologically based studies, the analysis tends to evolve around the multiple factors that can explain the adoption decision, tested in a larger sample of enterprises. The underlying premise is that a similar set of factors can explain adoption of technologies across a larger universe of enterprises and (more or less) same type of technologies.

4.1.1 Theories used in pre-existing adoption studies of electric vehicles (EVs)

Research on adoption of electric and hybrid vehicles in the consumer market has mostly relied on the psychological adoption approach (Egube and Long 2012; Ozaki and Sevastyanova 2011). Yet, more recent psychologically based studies have extended this theoretical platform by including social-psychological theories (Noppers et al. 2014). For instance, Schuitema et al. analyze instrumental, symbolic, and hedonistic attitudes related to adoption of electric vehicles in the UK (Schuitema et al. 2013). Traditional attitude theory is extended with "self-image congruency theory". These studies in general support that adoption of sustainable innovations does not exclusively depend on their instrumental attributes. Potential buyers may also be motivated to adopt electric vehicles by their positive environmental and symbolic attributes.

The multiple attitudes towards electric vehicles has been further explored in studies more closely aligned with a social constructivist approach (Heffner, Kurani and Turrentine 2005). Heffner et al. have studied the symbolic aspect of consumption and adoption of hybrid cars in the US based on ethnographic studies of 25 households. In a parallel stream of research, hybrid electric cars have been studied using transition management theories (Nilsson, Hillman and Magnusson 2012). For instance, Dijk and Yarime (2010) have used the TM framework in their analysis of electric engines in the automobile market.

4.1.2 Theories used in pre-existing adoption studies of mobile media applications (MMA)s

There are few, if any, published studies analyzing the adoption of MMA technology in SMEs. There is, however, a plethora of studies analyzing adoption of ICT in SMEs, exploiting all of the theoretical approaches outlined above. For a review; see Korpelainen (2011), Klewitz and Hansen (2013) or Consoli (2012).

4.2 CRAFTTRANS design and approach

The CRAFTTRANS project will conduct a survey of SMEs followed by in-depth studies of the implementation and use of EUV and MMA technologies.

An objective of the project is to come to an understanding of the diffusion and adoption process, so that policy-makers and other stakeholders can support and enhance a shift towards more sustainable transport among SMEs. We argue that wp3 and 4 are seen as interconnected research tasks.

- The survey provides insight into overall variation in the diffusion and adoption of EUVs.
- The qualitative studies are used to further explore insights related to how EUVs and MMA technologies are implemented in daily work routines and spur transformation in mobility patterns and work processes.

Yet, the two work packages may rely on slightly different theoretical approaches. Given the constraints of a managerial survey, we suggest that wp3 exploits an integrated analysis of determinants, such as proposed by Frambach et al. (2002) as well as psychological approaches. The proposed set of factors should be critically reviewed, however, and if necessary either extended or reduced.

Wp4 will follow up insights from wp 3 but also generate new knowledge on adoption processes in crafts enterprises. Compared to EUVs, MMA is a fairly new technology that can be assumed to have a high "interpretative flexibility" that makes a social constructivist approach particularly relevant. The work in this work package could also make use of the social network approach in the adoption process, drawing attention to the particular reties and bonds that that initiate and strengthen the adoption of EUVs and MMA. Methodologically this, might however be more challenging task if one consider to gather personal or full scale business networks.

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