

# Transformation 4.0

*A Closer Look at Mode of Operations in Nokia GOPS*

Ricardo Ernesto Díaz Chicaíza

Thesis Report



# Transformation 4.0

A Closer Look at Mode of Operations in Nokia GOPS

by

**Ricardo Ernesto Díaz Chicaíza**

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<b>Thesis Committee</b>	Prof. dr. ir. Ibo van de Poel	Chair
	Dr. Frank Guldenmund	First Supervision
	Dr. ir. Victor Scholten	Second Supervision

Student Number: 4180755

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# Summary

The fourth industrial revolution (Industry 4.0) is in full swing and organisations across the world pour efforts into the digitisation of manufacturing operations and services. The working practice changes and entails an increasing interaction of humans with technology. At the same time, from across society actors exert growing pressure on organisations to uphold accountability and other social values.

Industry 4.0 rises concerns over the organisation's current ability to support employee well-being. Here, well-being refers to the quality of an employee's working experience. In addition to an adequate physical and cognitive workload when performing tasks, factors influencing well-being include continuous competency development, synchronisation of one's work with that of colleagues, and recognition of one's contribution to the purpose of the organisation. Responsible Innovation, as a lens to improve the innovation process and anticipate social concerns such as that of well-being, remains appropriate for decision-making in governmental and academic settings. However, its use in industry is underrepresented and still unfamiliar to managers.

This thesis project is conducted in collaboration with Nokia Solutions & Networks. The project explores how can Responsible Innovation benefit the employee well-being in the Transformation 4.0 of the associated company? The project follows a Trailing Research approach. This is similar to action-research, but it is executed in only one cycle and its goal is not to trigger change. The organisation does not have the explicit request to address a problem. Instead, it commissions this study in order to explore possible impact of Industry 4.0 on their current mode of operations.

Therefore, the student-researcher trails the transformation inside the organisation during a 5-month research stay. Change brought by the design, execution, and evaluation of new digitisation projects is followed closely. From interviews to 9 practitioners across Human Resources, Change Management, Leadership & Talent, Demand Planning and Manufacturing groups, next to documentation analysis and contextual observation, a single case study with two embedded units of analysis—Business and Factory—is created.

The analysis results in the 9 Areas of Inquiry. These suggest a need to review current efforts in the organisation. The areas include a review: on traditional learning pillars; on the visibility of subject-experts across units and on current reward schemes; on the opportunity for rank-and-file to increase their outward-looking capability; on the way how groups capture and share lessons and how the impact of sharing is measured; on the understanding and monitoring of various forms of leadership; on the opportunity for the central change management group to transfer value to project groups in lower-levels; on employees' perception of the role of the continuous improvement function and how its methodologies are being transferred to the daily work of project groups; on the anticipation activities of more abstract future requirements for new tools; and on the mapping the evolving and diverse motivations of employees.

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Responsible Innovation brings its value by acting as a lens through which the aforementioned areas should be studied. This thesis recommends a first step to explore these areas. Namely, managers should start a reflection on current efforts by using 4 criteria: anticipation, reflection, inclusiveness, and responsiveness. These can be used to evaluate activities and adapt future ones. This is recommended as an extension of the manager's tool-set in decision-making pertaining to change. Its use in the company can bring employee well-being to a more central position in the discussion.

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# Contents

<b>List of Figures</b>	<b>vii</b>
------------------------	------------

<b>List of Tables</b>	<b>viii</b>
-----------------------	-------------

<b>1 Introduction to Research</b>	<b>1</b>
1.1 Problem Definition . . . . .	2
1.1.1 Need for Social Focus . . . . .	2
1.1.2 Well-being in Scope . . . . .	3
1.1.3 Opportunity for Responsible Innovation . . . . .	3
1.1.4 Company Case . . . . .	4
1.2 Research Objectives and Research Questions . . . . .	5
1.2.1 Research Objectives . . . . .	5
1.2.2 Research Questions . . . . .	5
1.3 Research Scope . . . . .	6
1.3.1 Delimitation . . . . .	6
1.4 Research Relevance . . . . .	7
1.4.1 Academic Relevance . . . . .	7
1.4.2 Corporate Relevance . . . . .	7
1.4.3 Social Relevance . . . . .	7
1.5 Thesis Outline . . . . .	8
<b>2 Research Design &amp; Methodology</b>	<b>9</b>
2.1 Research Approach . . . . .	9
2.2 Research Design . . . . .	11
2.3 Data Collection Methods . . . . .	11
2.4 Integration of Research Questions and Data Collection . . . . .	12
2.5 Quality Criteria . . . . .	13
<b>3 Literature Review</b>	<b>15</b>
3.1 Literature Review Methodology . . . . .	15
3.2 Well-being . . . . .	16
3.2.1 The Concept of Well-being . . . . .	16
3.2.2 Well-being inside the Organisation: The Working System . . . . .	17
3.3 Answering SRQ1 . . . . .	20
3.4 Industry 4.0 . . . . .	21
3.4.1 I40 Context . . . . .	21
3.5 Answering SRQ2 . . . . .	24
3.6 Responsible Innovation . . . . .	25
3.6.1 The RI Concept . . . . .	25
3.6.2 Motivation of RI . . . . .	25
3.6.3 Connection to other Theories . . . . .	26
3.6.4 RI Framework . . . . .	26
3.6.5 RI Integration to Well-being . . . . .	27



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3.6.6	Opportunities for Practice . . . . .	27
3.6.7	Obstacles for Practice . . . . .	28
3.7	Answering the SRQ 3 . . . . .	29
<b>4</b>	<b>Results: Corporate Case</b>	<b>30</b>
4.1	Introduction to Company . . . . .	30
4.1.1	GOPS Background . . . . .	30
4.1.2	Transformation 4.0 . . . . .	30
4.2	Data Collection in Company . . . . .	32
4.2.1	Interview Procedure . . . . .	32
4.2.2	Interview Sample . . . . .	33
4.2.3	Limitations of Data Collection . . . . .	33
4.2.4	Coding & Documentation Analysis . . . . .	33
4.3	Interview Results: Organisation . . . . .	35
4.3.1	Highlights of Interviews: Round One . . . . .	35
4.3.2	Intermezzo – Four Clusters of Inquiry . . . . .	37
4.3.3	Highlights of Interviews: Round Two . . . . .	37
4.4	Interviews Results: Units . . . . .	39
4.4.1	Unit A: Business . . . . .	39
4.4.2	Unit B: Factory . . . . .	40
4.5	Answering the SRQ4 . . . . .	42
<b>5</b>	<b>Discussion</b>	<b>43</b>
5.1	The 9 Areas of Inquiry . . . . .	43
5.1.1	Learning Pillars . . . . .	43
5.1.2	Recognition and Visibility of Expertise . . . . .	43
5.1.3	Interaction with External Actors . . . . .	44
5.1.4	Transparency of Change Learning . . . . .	44
5.1.5	Leadership Capability . . . . .	45
5.1.6	Change Aspects in Implementation . . . . .	45
5.1.7	Continuous Improvement Capability . . . . .	45
5.1.8	Concern on New Forms of Work . . . . .	46
5.1.9	Professional Identity . . . . .	46
5.2	Opportunities & Obstacles for Responsible Innovation . . . . .	47
5.2.1	Answering the SRQ5 . . . . .	47
5.2.2	Answering the SRQ6 . . . . .	48
<b>6</b>	<b>Conclusion &amp; Recommendations</b>	<b>49</b>
6.1	Research Questions . . . . .	49
6.1.1	The Road towards the Research Question . . . . .	49
6.1.2	Answer to the Research Question . . . . .	51
6.2	Implications . . . . .	52
6.2.1	For Practice . . . . .	52
6.2.2	For Organisations . . . . .	54
6.3	Future Work . . . . .	55
6.4	Reflection . . . . .	57
6.4.1	On Research Objectives . . . . .	57
6.4.2	On Research Approach and Methods . . . . .	58
	<b>Bibliography</b>	<b>59</b>
	<b>Appendix A Ch.2 Research Design &amp; Methodology</b>	<b>65</b>
A.1	Quality Criteria . . . . .	65

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<b>Appendix B Ch.3 Literature Review</b>	<b>67</b>
B.1 Literature Review Methodology . . . . .	67
B.1.1 Step I: Defining the Scope . . . . .	67
B.1.2 Step II: Conceptualising the Topics . . . . .	68
B.1.3 Step III: Searching for the Literature . . . . .	69
B.1.4 Step IV: Analysing and Synthesising the Literature . . . . .	70
B.1.5 Step V: Setting the Research Agenda . . . . .	70
B.2 Well-being: Working System . . . . .	72
B.2.1 Organisation . . . . .	72
B.2.2 Environment . . . . .	73
B.2.3 Technology . . . . .	73
B.2.4 Task . . . . .	73
B.2.5 Individual . . . . .	74
B.2.6 Commentary on Categories and Factors . . . . .	75
B.2.7 Links WB Factors and I40 Areas of Concern Clarification . . . . .	76
B.2.8 Supporting Diagrams . . . . .	78
<b>Appendix C Ch.4 Results: Corporate Case</b>	<b>79</b>
C.1 Data Collection in Company: Documentation Analysis . . . . .	79
C.1.1 Organisation Documentation Analysis . . . . .	79
C.1.2 Extension of Factory Documentation Analysis . . . . .	81
C.1.3 Research Agenda: Inquiry on Organisation Project Methodology . . . . .	82
C.2 Data Collection in Company: Interview Protocol . . . . .	83
C.2.1 Interview Protocol for Round I . . . . .	83
C.2.2 Interview Protocol for Round II . . . . .	84
<b>Appendix D Ch.5 Discussion</b>	<b>85</b>
D.1 Opportunities & Obstacles for Responsible Innovation . . . . .	85
D.2 RI Opportunities . . . . .	85
D.3 RI Obstacles . . . . .	87

# List of Figures

2.1	Project Execution based on the 5 Stages of Trailing Research . . . . .	10
2.2	Case Study Design for Study in Company. Single Case at GOPS Function with two Embedded Units, Business and Factory . . . . .	11
2.3	Case Study Framework. Connection of Research Questions with Data Collec- tion Methods . . . . .	12
3.1	5 Steps for Documenting Literature Review. Recommended Guidelines . . . .	16
3.2	Working System Characterisation. 4 Categories and Example of Influencing Factors on an Individual's Well-being . . . . .	18
3.3	Balance Theory Depiction. Working System Loads on Individual may lead to Imbalance resulting in Stress and Strain . . . . .	19
4.1	Company's Mode of Operations: Innovation Funnel recommended by Gartner Consultants for use in Nokia GOPS . . . . .	31
4.2	Company Case Study: The 6 Steps of Data Collection Execution . . . . .	32
6.1	Responsible Innovation: Critical Reflection Exercise Example . . . . .	53
B.1	Working System Depiction as presented by Genaidy et al. [52] . . . . .	78
B.2	Socio-Technical System Depiction as presented by Oosthuizen and Pretorius [57] . . . . .	78

# List of Tables

1.1	Report Structure. Connection between Research Questions and Chapters . .	8
2.1	Overview. Connection of Research Questions with Data Collection Methods .	12
3.1	Scope of the Literature Review. Characteristics of the Review according to three central topics: WB, I40, and RI . . . . .	15
3.2	Selection of Relevant Factors of the Working System for the Exploration of Well-being in an Organisation . . . . .	20
3.3	Output of Literature Review on Industry 4.0: The 5 Areas of Concern . . . .	22
3.4	Connections between Well-being Factors and the 5 Areas of Concern of Industry 4.0 . . . . .	24
4.1	Company Case Study: Overview of Interview Sample . . . . .	33
4.2	Guiding Coding for Connection of Areas of Inquiry to Well-being Factors . .	34
4.3	Presentation of Results based on 9 Areas of Inquiry . . . . .	35
4.4	Current Organisational Efforts to address Social Concerns . . . . .	42
5.1	Summary of Findings & Areas of Concern . . . . .	47
5.2	Opportunities for Responsible Innovation in the Study of the Areas of Inquiry	48
5.3	Obstacles for Responsible Innovation in the Study of the Areas of Inquiry . .	48
B.1	Taxonomy of Literature Review: Categories and Characteristics . . . . .	67
B.2	Keyword Identification around Central Topics . . . . .	68
B.3	Comparison of Relevant Journals on Responsible Innovation . . . . .	70
B.4	Search Queries around Central Topics: Singular and Combinations . . . . .	71
B.5	Clarification. Connections between Well-being Factors and the 5 Areas of Concern of Industry 4.0 . . . . .	76
D.1	Clarification. Opportunities for Responsible Innovation in the Study of the Areas of Inquiry . . . . .	85
D.2	Clarification. Obstacles for Responsible Innovation in the Study of the Areas of Inquiry . . . . .	87

# Chapter 1

## Introduction to Research

We live at exciting times of technological transformation. Smart technology invades our homes, offices, and public spaces. Technology becomes more than a simple assistant in the execution of daily tasks, a companion. Advancements in software and telecommunications support this evolution. The internet unifies people around the world. At industry the power of the internet is coupled to that of embedded systems and eventually a seamless integration of humans, physical objects, systems, and processes will be achieved. This intelligent, inter-connected, agile value-chain is the premise of the fourth industrial revolution (Industry 4.0) [1].

It is remarkable how technology diversifies and advances in functionality, speed, capacity, and connectivity. These advancements offer organisations the opportunity to improve the way they provide products and services to society [2]. For this, they need to *transform*, they need to change how they operate. Employees face the challenge of initial change. New roles are created, new forms of work are specified. They face the uncertainty of how they should adapt and whether they will actually succeed. If the organisation disregards the value of their expertise and fails to persuade them in joining the change, employee engagement towards the workplace becomes an issue. On top, with altered team relationship and discomfort with content of daily tasks, employees are at a psychological and physical risk [3].

On the contrary, when the uncertainty of change is managed with clear communication, active leadership, and employee involvement, their engagement towards the new workplace is likely to increase. The management of change, however, becomes more complex with the faster and more diverse introduction of technology. Industry 4.0 will only accelerate this trend. Therefore, it is imperative to reinforce the managerial tool-set for dealing with change; a fit tool-set for the **Transformation 4.0**. This study looks at how managerial knowledge can be updated, so that in times of industrial transformation the changes in the technology practice better support the well-being of employees.

This first chapter has 5 sections. **Section 1.1** defines the research problem; **1.2** indicates research questions and objectives; **1.3** indicates the scope and **1.4** the relevance; finally, **1.5** provides the outline of the report.

<b>Section 1.1</b> Definition	<b>Section 1.2</b> Objectives	<b>Section 1.3</b> Scope	<b>Section 1.4</b> Relevance	<b>Section 1.5</b> Outline
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## 1.1 Problem Definition

### 1.1.1 Need for Social Focus

This first section argues that the Transformation 4.0 has, besides its technical, a strong social focus. The Industry 4.0 vision presents humans and technology continuously interacting in the workplace. Thanks to the increased interaction, humans may be relieved from repetitive and strenuous physical tasks. Gradually, however, this interaction or automation takes over cognitive tasks involving calculation and coordination of information. This redefines employee tasks in content, time and space [4], thereby bringing implications for individuals and departments.

Individuals need to update their set of skills and competencies [5]. Innovativeness and creativity is expected, so departments need to work on new trainings and flexible learning models. However, not all employees can easily join the new learning. The challenge is to increase their motivation, allow them to first grasp the present state, and, then, mobilise them to next one [6]. Here, efforts from Human Resources (HR) and Change Management (CM) groups prove critical. Under-qualification and possible job loss due to machine substitution also trouble employees. Their anxiety should be assuaged through clear communication, involvement, and active leadership. These efforts likely mobilise other resources and bring about new forms of collaboration between groups. Organisational structures should ideally be reviewed to verify they support these collaborations [7]. They often result in valuable knowledge which should be timely captured [8].

Furthermore, social implications follow from current employees' expectations on work-life balance. Achieving material needs through one's work is becoming less important. Instead, achieving intangible needs as the exploitation of communication capabilities is a new priority [9]. Employees want to interact actively inside and outside their jobs. Through increased social interaction, they seek a better support of their work for creating a larger societal impact [10]. From the HR's standpoint, this should not be a complicated balance but an opportunity. The Transformation 4.0 brings an increased industrial complexity, which demands the ability of workers to act across teams and resolve independently context-bound decision-making. Increased social interaction can provide a training ground for building and reinforcing the necessary skills [10].

However, maximising spaces for interaction and adapting sharing structures necessitates time and resources. *Would these efforts pay off?* Business research tells us that they will. Company performance is not sacrificed by improvement of these *social aspects* in the workplace. Achieving technical and social goals can be simultaneously pursued and can lead to joint positive results [11, 12]. Transformation 4.0 builds on technical results as higher productivity, shorter delivery times, improvements on product quality and customer service; as well as on social results as the betterment of the “well-being of the organisation's community and that of individual employees” [13, p.2].

In sum, the Transformation 4.0 raises valid and interesting questions on how organisational efforts currently support social aspects (e.g., employee learning, sharing across groups, support structures for employee interaction and reward). Technical uncertainty (e.g., what new technologies will make one's business competitive) should not overshadow the social aspects, for efforts can contribute to both ends and increase bottom line and employee well-being [14, 15].

### 1.1.2 Well-being in Scope

This next section narrows down the discussion on social aspects to the concept of well-being. Well-being can be taken as the highest value that enables people to live the good life [16, p.367]. In our daily life we also relate to other values as safety, health and privacy. Though, their realisation is a pre-condition for well-being to exist [17]. They are subsumed. In an organisation, well-being is defined as the overall quality of an employee's experience and functioning at work [18]. Managers can address it through its psychological, physical and social dimensions [19]. The psychological dimension, for instance, refers to satisfaction and commitment employees have towards their job; the physical alludes to musculoskeletal effort; and the social to the working relationship with colleagues and leaders.

New tools, new trainings, and new forms of interaction are new experiences for employees. They exert pressure on employees and as a result, employees compensate through their mental and physical effort to maintain the balance. If they fail to compensate, imbalance ensues, and their well-being, their health can be severely affected [3]. The managerial challenge is to ensure that actions meant to positively develop the employee (e.g., social and psychological dimensions) do not come at the expense of the worker's physical health. Think, for instance, that with the Transformation 4.0 short sprints of learning are needed; this can reassure employees of their value to the company, but, if trainings are not properly planned and balanced, they may lead to increased stress and employee resistance [20].

Additionally, the Transformation 4.0 brings a quick deployment of new technologies in the workplace. The impact of certain devices on an employee's well-being is uncertain. They process large amounts of private data and its storage may not be completely safe [21]. Moreover, if a device is misused and results in harm to other employees, who is responsible for these undesired actions? Employees cannot simply be operators that fit the new system. The practice around them should be designed with considerations for their personal privacy and responsibility [22]. Designing with these and other positive values in mind means designing a practice for well-being.

### 1.1.3 Opportunity for Responsible Innovation

The design of such practice is difficult due to the novelty and inherent uncertainty of new technologies. However, the exploration of their impact on employee well-being is possible and should be desired. The anticipation of negative scenarios does not put unnecessary constraints on the Transformation 4.0. Conversely, it reinforces the ethical pillars (e.g., worker's safety, sustainability, and privacy) of the new practice and represent a progress for the morality of the organisation [23].

A design principle for this purpose is that of the inclusion of employees during the design and implementation process. This broadens and enriches the technology-centred discussion. With the reflection of more employees on undesired scenarios risking their privacy and safety, countermeasures are more likely to be designed. The transformation is not static in time, so the organisation should adapt operations to increase the impact of these inclusive and anticipatory activities.

Responsible Innovation (hereinafter RI) is suggested as a tool, or framework, that can assist the process and improve the impact of innovation in the company and society. RI is not an off-the-shelf fix to comply with social demands for upholding values, as that of well-being. Instead, it suggests mechanisms—of anticipatory, reflexive, inclusive and responsive nature—for a new form of governance in the organisation [24]. In recent years it has gained popularity among scholars and policy-makers, but it still is underrepresented in companies

[25]. This presents an opportunity for its practical study. In the face of uncertainty and change due to the Transformation 4.0, can RI assist the exploration of technology impact on employee well-being?

#### 1.1.4 Company Case

To provide practical context to the Transformation 4.0, this thesis project is proposed as a research collaboration between university and company. The research is conducted with Nokia Solutions & Networks. A major player in the telecommunications industry, with global presence and with over 100,000 employees in over 100 countries. The company provides a relevant change context as it has experienced multiple acquisitions and merges in the last decade; moreover, it is actively evolving their mode of operations towards the Industry 4.0 vision. The study is conducted at the Global Operations (GOPS) corporate function. They orchestrate multiple digitisation projects for the improvement of the company's supply chain. Specifically, the study is embedded in the Strategy Development group. Their work has direct impact on over 5000 employees across the GOPS units all around the world.

Part of their work towards their strategy 4.0 is directed to the exploration of change and its impact on employee well-being. With increased technology deployment, redefined working functions, and new collaborations between units, they also ask, what are those new learnings for our employees and how should our managers prepare our people to embrace the Transformation 4.0? This thesis collaboration emerges from this need. **Chapter 4** provides more company details and context of study. In the interest of research neutrality, the company is hereinafter referred to as **the associated company**.

The **Problem Definition** is:

The associated company has launched multiple projects for bringing new digital tools and processes inside the office. Employees have expressed resistance to the change these projects entail and there may be other undesired consequences of new technology on employee well-being. The company strives to mitigate the impact and hence, it commissions a review of its current mode of operation and how the practice supports employee well-being. The thesis explores the company's Transformation 4.0 and based on Responsible Innovation provides managerial feedback for the design of ongoing and future activities.



## 1.2 Research Objectives and Research Questions

### 1.2.1 Research Objectives

The objectives of the study are:

1. Explore the impact of the Transformation 4.0 on the employee well-being;
2. Identify actions of the associated company to mitigate the negative impact of the Transformation 4.0 upon employee well-being;
3. Recommend actions based on Responsible Innovation to address possible gaps and thus support well-being;
4. Indicate opportunities and obstacles for Responsible Innovation in the current practice;
5. Contribute to the Responsible Innovation literature for its standard use in industrial practice.

### 1.2.2 Research Questions

Based on these objectives, the main research question (**RQ**) is proposed to be:

**How can Responsible Innovation benefit the employee well-being in the Transformation 4.0 of the associated company?**

The following sub-research questions (**SRQ**) guide the answering of the main research question:

- **SRQ1:** How can employee well-being be explored in a company?
- **SRQ2:** What social concerns of the Transformation 4.0 may impact the employee well-being in a company?
- **SRQ3:** What does a Responsible Innovation approach suggest with respect to the Transformation 4.0?
- **SRQ4:** How does the associated company manage the impact of the Transformation 4.0 on employee well-being?
- **SRQ5:** What opportunities does Responsible Innovation offer for supporting employee well-being in the associated company?
- **SRQ6:** What obstacles does Responsible Innovation face in supporting employee well-being in the associated company?

## 1.3 Research Scope

### 1.3.1 Delimitation

In the interest of clarity, the study has the following scope:

1. **Extension of Transformation:** The vision of the fourth industrial revolution is pervasive in the manufacturing industry and is gradually gaining presence in other industries (e.g., [26]). It includes the introduction of various technologies and various smart concepts (e.g., [27, p.41]). The concept of Transformation 4.0 in this study refers to the organisational change required and brought by the Industry 4.0. The terms is mainly used in the change context of the associated company; namely, change brought by the introduction of new technology projects at the Global Operations function of the associated company. These units and projects are aligned with the industrial vision of Industry 4.0. More information on the company and projects is given in **Section 4.1** and the Industry 4.0 background is presented in **Section 3.4**.
2. **Extension of Well-being:** The unit of analysis for discussing the impact on well-being is limited to the company's boundaries. Interactions of employees with their immediate community or with the larger welfare state of their country (e.g., [28]) are not considered. In addition, well-being is studied through its psychological, physical, and social dimensions and a list of relevant factors to each dimension is suggested. This is the output of **Section 3.2**.
3. **Extension of Responsible Innovation:** The definition for RI is based on the work by Von Schomberg [29] and the framework by Stilgoe et al. [30]. This work defines the RI approach and as part of the literature review, additional remarks on the concept are given **Section 3.6**.
4. **Extension of Employees:** The term employees is used to refer to various roles: operators, technicians, managers and engineers. If appropriate a specification of the working role is made, otherwise, the term employee is used indiscriminately inside the organisation.

## 1.4 Research Relevance

### 1.4.1 Academic Relevance

Two reasons make this project academically relevant:

- It takes an unusual angle on Design for Well-being;
- It explores Responsible Innovation in an unconventional setting.

The first question that pops up is whether designing for well-being is actually possible. Yes, this is possible and can be executed by practitioners [31]. There are a number of approaches to this end: for instance, Life-based Design by [32] or Design for the Elderly [33]. However, these approaches are meant for the design of technological objects and the users of these objects are often market customers. In this project, the focus is on the design of a working practice and the users in this case are employees.

Secondly, interventions of similar nature to that of the RI approach (i.e., embedding social and ethical consideration in the innovation process) have been mostly conducted in R&D departments and laboratories (e.g., [34, 35]). Instead, this project is conducted in a global operations function, specifically in the strategy group of the company's supply chain. This is an attempt to understand what drives and hinders RI in such corporate settings and hence this study addresses the underrepresentation of RI in business contexts [25, 36].

### 1.4.2 Corporate Relevance

One compound reason makes the project industrially relevant:

- It updates the control and measure of employee well-being and assesses the feasibility of Responsible Innovation in the associated company's practice.

In practice, a company often strives to ensure values as privacy or safety. These values are practically measurable: for instance, through the number of accidents per month or duration of employee leave. This study takes a step back and holistically considers the higher value of well-being. Through this exploration more questions on the working conditions of employees are triggered (i.e., as there are more factors being considered). More is not necessarily better, but at this exploratory stage of the Transformation 4.0 (and with the first thesis project of this nature in the working group) the scope should aim to be comprehensive in coverage. The output of the project presents relevant information on how actions of the associated company support well-being and how they may be improved by the RI approach.

### 1.4.3 Social Relevance

Finally, the project is socially relevant for two reasons:

- Well-being begets well-being;
- Citizen and employee empowerment.

Firstly, if employee well-being increases, the positive effects of well-being are likely to be transmitted to other members of the working community, and to other individuals in close

relationship with the employees, including their families [37]. In addition, in line with the future vision of Malaska [9], our society increasingly places human interaction as a top priority. With workplaces being an integral part of our lives, organisations across society should support people in making the most out of their desire for interaction and their desire to give back through their work. The knowledge output of this thesis can be relevant to other organisations, as public offices and universities. People at these job posts could find learnings from this study applicable to their context and, through the knowledge, feel empowered to take action from their working positions.

Finally, this study is also relevant in that its output *infinitesimally* contributes to the request to organisations to do more for their human capital—to do more for a human-centred transformation. Employee job loss due to machine substitution is major concern of the Transformation 4.0. This study supports the idea of investing more on training and education, and on fitting the system to the employee, before pushing the employee to fit the system.

## 1.5 Thesis Outline

The report is structured in six chapters. **Chapter 1** provides the background, objective, and strategy of this project. **Chapter 2** presents the research methodology. **Chapter 3** reviews the central literatures subjects of this study. **Chapter 4** introduces the corporate the case and highlights the input obtained from interviews and documentation analysis. **Chapter 5** analyses the corporate findings and discusses against the reviewed literature. Finally, **Chapter 6** provides answer to the study’s research question, specifies the implications for practice, and reflect on the limitations of the study and need for future work. **Table 1.1** presents the overview of the research questions and their location in the report.

Table 1.1: Report Structure. Connection between Research Questions and Chapters

Research Question		Ch.	Sec.
<b>SRQ1</b>	Explore Employee Well-being in a Company	3	3.3
<b>SRQ2</b>	Social Concerns of Transformation 4.0	3	3.5
<b>SRQ3</b>	A Responsible Innovation Approach	3	3.7
<b>SRQ4</b>	Company Efforts to Manage Impact on Well-being	4	4.5
<b>SRQ5</b>	RI Opportunities in Company	5	5.2.1
<b>SRQ6</b>	RI Obstacles in Company	5	5.2.2
<b>RQ</b>	Can RI benefit Employee Well-being in Company?	6	6.1

## Chapter 2

# Research Design & Methodology

This second chapter has 5 sections. **Section 2.1** introduces the research approach; **2.2** presents the selected analytic framework; **2.3** specifies the data collection methods; **2.4** integrates the output of the previous sections; and **2.5** concludes with the quality criteria used for the research.

<b>Section 2.1</b>	<b>Section 2.2</b>	<b>Section 2.3</b>	<b>Section 2.4</b>	<b>Section 2.5</b>
Approach	Design Framework	Methods	Integration	Quality Criteria

### 2.1 Research Approach

Trailing Research (TR) is the selected research approach for the project. This is a variation of the more popular action research. TR differs in that the goal of the project is not to bring change and the researcher does not act as a change agent [38]. Before continuing with TR, action-based approach is in the first place suitable for this study due to three of its general features [39, 40]:

- The study is a collaboration between practitioner and researcher;
- It inquires upon organisational change;
- It aims to contribute to the academic field through the integration of practice and research.

However, when considering additional features of its execution [41], the study does not comply with:

- The need for flexible planning, as the project content and direction are defined from the beginning;
- The need for study iterations, as the study is time-limited and only allows for one intervention cycle;

The strong emphasis of action research on the project goal and the role of the change agent is circumvented by TR as it suggests [38, p.155] with respect to:

- **Objective:** that the researcher need not introduce a new content or way of working in the organisation. At most, recommendations and feedback based on international research and on insights derived from theory are given;
- **Role:** that the role of the researcher does not entail responsibility for facilitating change.

Based on these two features, it is important to note that Transformation 4.0 inside the associated company has already been initiated. It is assumed that there is no concrete problem that should be solved. Rather, there is an explicit interest to explore whether the ongoing transformation could be improved. In this way, TR enables the researcher “to trail the transformation program real time with the methodology of social sciences to create analyses that could be interpreted and ultimately made sense by involved actors” [inside the organisation and back at the research institution] [42, p.15]. TR has 5 stages [38] as presented in **Fig. 2.1**.



Figure 2.1: Project Execution based on the 5 Stages of Trailing Research

1. Negotiation and Setting up of the Project;
2. Design of the Study;
3. Collecting Data from Multiple Sources and Levels;
4. Analysis of Data;
5. Communication of Findings to Company and Academic Institution.

## 2.2 Research Design

The selected analytic framework is that of a case study. Case studies are commonly selected for collaborative investigations between research institutions and organisations, universities and companies [38, 43]. A case study is an appropriate choice because of two reasons: one, the study has an **exploratory** purpose; and two, the transformation under study is located in its natural context (i.e., investigating employee well-being inside the organisation), which implies that the researcher has no influence nor control over the phenomenon [44]. Further, the case study is designed to look at a **single case with two embedded units of analysis** as depicted in **Fig. 2.2**. The boundary of the single case is the Global Operations function at the associated company; and the two embedded units are the business and factory unit. The selection of these boundaries follows after consultation with the supervisory team inside the company. These two units are motivated as they bring a more technical view on project and data of their cases is available. **Section 4.1** explains more in detail the boundaries of study and the two selected units.

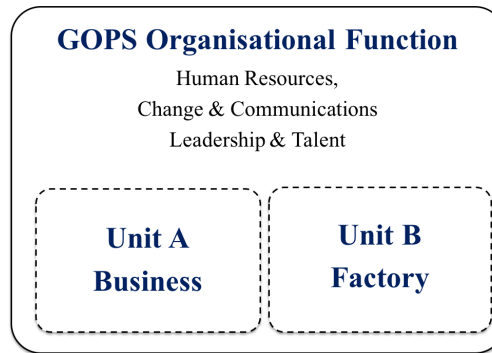


Figure 2.2: Case Study Design for Study in Company. Single Case at GOPS Function with two Embedded Units, Business and Factory

## 2.3 Data Collection Methods

In terms of data sources the following four are used for building the case:

1. Systematic literature review;
2. Semi-structured interviews;
3. Documentation analysis;
4. Contextual observation.

The foundation of the theoretical framework is obtained from the **literature review**. This is conducted around three subjects: Well-being, Industry 4.0, and Responsible Innovation. **Section 3.1** documents the review and provides information on its execution.

The context of the case study is provided by the **documentation analysis**, the **contextual observation**, and **9 interviews** to people inside the associated company. Details on interview procedure and sampling, use of coding, and limitations are given in **Section 4.2**.

## 2.4 Integration of Research Questions and Data Collection

**Fig. 2.3** shows how the theoretical framework is first structured to support the execution of the case study. The literature review gives answer to sub-research questions one, two, and three; and the case analysis addresses sub-research questions four, five, and six. The overview of data sources, their connection to sub-research questions, and their location in this report is provided in **Table 2.1**.

Table 2.1: Overview. Connection of Research Questions with Data Collection Methods

Question	Subject	DR	DOC	INT	OBS	Section
<b>SRQ1</b>	Explore Employee Well-being in Company	Yes		-		3.3
<b>SRQ2</b>	Social Concerns of Transformation 4.0	Yes		-		3.5
<b>SRQ3</b>	A Responsible Innovation Approach	Yes		-		3.7
<b>SRQ4</b>	Company Efforts to Manage Impact on Well-being	-		Yes		4.5
<b>SRQ5</b>	RI Opportunities in Company	-		Yes		5.2.1
<b>SRQ6</b>	RI Obstacles in Company	-		Yes		5.2.2
<b>RQ</b>	Can RI Approach Improve WB in Company?			Yes		6.1

*DR: Desk Research, DOC,: Documentation, INT: Interview, OBS: Observation, -: No*

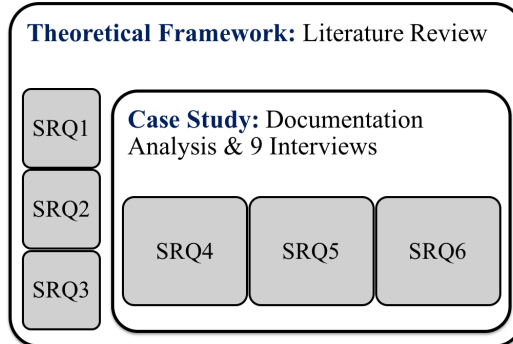


Figure 2.3: Case Study Framework. Connection of Research Questions with Data Collection Methods



## 2.5 Quality Criteria

The nature of the study as a one-off intervention raises concerns on the project’s validity and replicability [44]. Validity is understood as the accuracy of measuring what has been intended; and replicability as the degree to which the study can be replicated in a different setting and still result in similar findings. These criteria are widely used in quantitative research, however, in qualitative research they may be too strict as there is not one absolute social reality with exact measures and exact replication later in time. An alternative for ensuring the quality, rigour and wider implication of research is captured by the concept of Trustworthiness. This was originally proposed by Lincoln and Guba [as cited in [45]] and includes the following four criteria: **credibility**, **transferability**, **dependability** and **confirmability**.

### Credibility

Credibility is similar to internal validity in quantitative research. It refers to the accuracy of measuring what is intended to be measured. Main measurements of the study follow from interviews. **Respondent Validation** supports this criterion. After the interviews, notes taken are summarised and shared with interviewees to validate that answers are not misinterpreted and that participants correctly understood questions and concepts used. Credibility also refers to the researcher’s accuracy for reporting the data obtained. Regarding data from documentation, these unfortunately may only be accessed by employees in the company. However, the data is only used for the context setting of interviews and for answering the SRQ4—the company’s current efforts on well-being. Both results are treated in validation discussions with the supervisory team in the company and they are presented in documentation analysis and interview protocols found in **Appendix C.1** and **C.2**.

This last validation step forms part of the **triangulation strategy** of the study. Triangulation increases credibility [45] as it allows to cross-check data through various sources. Though, note that in the context of action-based-research, triangulation is more than a one-off cross-checking and becomes a cyclical way of collecting data through the continuous and varied exposure to data sources [43]. In this study, triangulation includes validation points after interviews, pre and post-interview consultation with supervisory team, and other informal meetings with team and staff. This allows, for instance, to select the most relevant well-being factors for the company (see **Table 3.2**) and to rehearse the interview protocols.

### Transferability

Transferability is akin to external validity. Are findings transferable to other cases? This criterion is well addressed by documenting the investigation process in a detailed manner. A thick account of details is given for the literature review process in **Section 3.1** and the case study introduction and data collection in **Section 4.1** and **4.2**, respectively.

A limited action for transferability in this study is that of coding. As suggested by Yin [44], data from contextual observations and informal interactions may be abundant, so a case study database should be established for documenting the chain of evidence. This does not form part of the report and the use of coding is limited to the preparation and analysis of interviews. **Section 4.2** gives additional remarks on coding and its limitations. Finally, as part of the study’s conclusion, **Section 6.2** comments on how findings and reflections from the case study can be transferrable to other organisations.

### **Dependability**

Dependability is close in meaning to reliability in quantitative research. It refers to the time dependency of the results. The idea is that reported findings and conclusions can also be obtained in a future by other researchers. This demands a careful record of the process and its accessibility. As commented with Credibility the process behind the literature review, the interview procedure, sampling, execution and analysis is documented in detail. This report is available online in the Delft University of Technology's repository for future review.

### **Confirmability**

This final criterion refers to the objectivity of the researcher. Personal values and views on the subject should not influence the research process and outcome. For this purpose, a personal reflection at the beginning of the project allowed to identify presupposed views on the subject. Also, these were indicated in a personal log and visited time to time to verify how ongoing actions were not affected by personal bias. **Section 6.4** includes a short reflection on the design and execution of the project.

As an additional quality check the criteria recommended by Eden and Huxham [43] are considered in **Appendix A.1**. Indeed, these criteria overlap with the aforementioned, but they are more specific in ensuring quality and rigour of action-based research projects. The trustworthiness criteria have a broader scope for business qualitative research.

## Chapter 3

# Literature Review

This chapter has 7 sections and provides the theoretical framework of the study. **Section 3.1** provides the methodology for the literature review; **3.2** reviews the subject of Well-being (WB) and its output is the basis for answering the sub-research question 1 (SRQ1) in **3.3**; similarly, **3.4** reviews the subject of Industry 4.0 (I4O) and answers SRQ2 in **3.5**; and finally, **3.6** reviews Responsible Innovation (RI) and answers SRQ3 in **3.7**.

Section 3.1	Section 3.2	Section 3.3	Section 3.4	Section 3.5	Section 3.6	Section 3.7
Methodology	WB	SRQ1	I4O	SRQ2	RI	SRQ3

### 3.1 Literature Review Methodology

The literature review is executed based on the guidelines by Von Brocke et al. [46]. Their 5 recommended steps are shown in **Fig. 3.1**. **Step I** defines the **scope of the review** through six categories, which include the focus of the search and its goal, the way how the material is presented and espoused, the extension of its coverage, and the audience to whom the review is directed. **Table 3.1** shows the overview of these categories in the context of the study. **Step II conceptualises the topic** through the exploration of keywords around Well-being, Industry 4.0, and Responsible Innovation. **Step III** consists of a preamble in where journals, databases, and search queries are defined; this is followed by the **literature search process**. In **Step IV** the relevant material is scanned, shortlisted, and **analysed**; it is the crux of the process. Finally, **Step V** recommends **next steps** for addressing literature gaps and forms the base of future work. For a **detailed description** of these five steps in the context of this project, please see **Appendix B.1**.

Table 3.1: Scope of the Literature Review. Characteristics of the Review according to three central topics: WB, I4O, and RI

	Well-being	Industry 4.0	Responsible Innovation
<b>Focus</b>	Theory & Applications	Applications	Theory & Applications
<b>Goal</b>	Integration	Central Issues	Integration
<b>Organisation</b>	Conceptual		
<b>Audience</b>	General Public & General Scholars		
<b>Perspective</b>	Neutral Representation		
<b>Coverage</b>	Exhaustive	Representative	Central & Pivotal

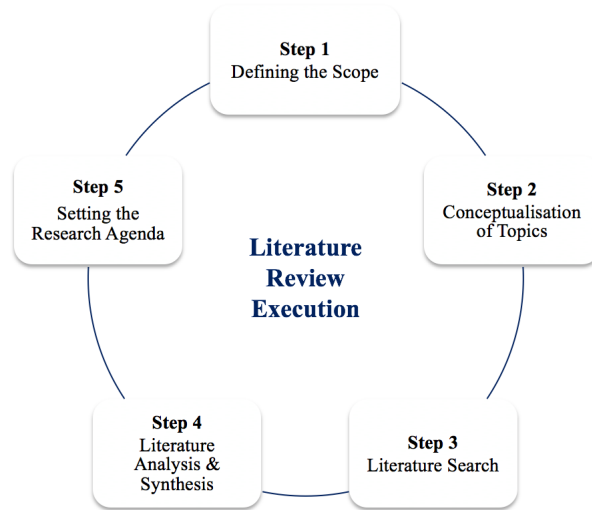


Figure 3.1: 5 Steps for Documenting Literature Review. Recommended Guidelines

## 3.2 Well-being

This section presents the literature review of employee well-being. The guiding question is what does literature say about dimensions and factors influencing employee well-being. From **Table 3.1** recall the review on well-being focuses on **theories and applications**. The goal is to **integrate** views from different disciplines on how well-being is measured in practice. It is organised **conceptually**: well-being, working system, and the system categories and influencing factors. The coverage of concepts is considered by the author as **representative** for the literature.

### 3.2.1 The Concept of Well-being

There are various conceptualisations of well-being. The four most prominent are hedonic, eudaimonic, quality of life (QoL), and wellness. Despite the theoretical distinctions and diverse use of terms, they all share “the foundational interest in the positive dimension of human experience and functioning, [...] they seek to define what is to live the good life” [47, p.733]. The existence of various concepts follows from the fact that they are rooted in different disciplines: hedonic and eudaimonic in psychology, sociology, and philosophy; QoL in medicine; and wellness in counselling. One could argue on the hedonic and eudaimonic influence on the other two, but that discussion falls out of the scope of the review. For an enriching exploration of these approaches, see the work by Ryan & Deci [48].

QoL presents, in Cooke et al.’s view [47], the most comprehensive way of measuring well-being in practice. Its measurement is based on the concept’s three dimensions—psychological, physical, and social. For each dimension a list of factors is composed. For example, in the psychological dimension, one finds job satisfaction as an influencing factor of someone’s well-being. The factors sometimes border the line of what is objective and subjective, what is verifiable and what resides in someone’s mind. Some factors may have broad definitions, as it is the case with job satisfaction. It may refer to satisfactory relationship with colleagues and with supervisors, or to satisfaction gained by individual work. This review does not aim to present one definition of each factor, however, for the context of the case-study a number of factors are later defined.

A second aspect of the QoL approach is that well-being is not taken as a yes-or-no state. Well-being does not exist because a factor exists or is missing. Rather, well-being should be seen as a process, which can be either intensified or abated depending on past experiences, present conditions, and future expectations [47]. Despite efforts to capture well-being in *a* concept with three dimensions, it is a malleable and time-dependent interpretation [28] that should be holistically approached. That is, the study of well-being is not centred in one dimension and on the effect of one factor, but on the interaction and combined effect of factors [3].

In the broad sense of the QoL approach, well-being is defined as “the highest value which enables people to live a good life” [16, p.367] and it is realised when other day-to-day values (e.g., safety, health and privacy) are achieved [17]. In *realising* the subsumed values one needs to consider the intricate interplay of factors pertaining to the social, professional, and private spheres of life. This means that the study of well-being extends from the individual to the collective perspective. The collective perspective in this case is delimited to the boundaries of a company. The interactions of work and private life, say, how one interacts in the community are not considered. For such an exploration, see the work by White [28] or by Christiansen and Matuska [49].

### 3.2.2 Well-being inside the Organisation: The Working System

If the unit of study is limited to an individual inside an organisation, well-being is defined as “the overall quality of an employee’s experience and functioning at work” [18]. This other approach is called the Working System and bears similarities with QoL, mainly in its holistic view on the physical, psychological, and social dimensions.

A challenge of managing dimensions in practice comes with well-being trade-offs. On the one hand, a company strengthens commitment of employees and seeks increase in productivity by offering new trainings; though, on the other hand, employees may suffer from increased stress if these activities are not carefully planned and balanced [19]. In the context of the Transformation 4.0, managers too face the challenge of balancing new tools and trainings with a creating a transparent change environment. The literature calls this discussion as that of mutual gains and conflicting outcomes—should well-being be approached holistically and as a requisite of organisational performance? The quantitative work of Van de Voorde et al. [11] and Ramstad [12] suggests this is possible; the more qualitative rationalisation of Kalmi and Kauhanen [50] also supports this position. Evidence against is mainly directed to the lack of correlation between factors e.g., job autonomy and work commitment (cf. Dhondt et al. [51]).

This thesis supports the view of ensuring well-being for advancing the organisational practice [52]. This also finds support in other authors who go further to emphasise the need for well-being due to its positives. Namely, positive business results by having addressed well-being is known to us [53, 54], so the current practice should not only praise the care of well-being when negatives are balanced. The work of ergonomists is justified when cases of frustration, pain, stress, fatigue, overload are avoided. It is interesting to think about emphasising the opposite, instead. That is, actions are sought and praised when employees have a better time and enjoy a more optimal health-state. Here, the profession would be that of hedonomics viz., experts who in the context of change seek the promotion of pleasurable human-technology interaction [55]. This, however, brings the challenge of understanding well-being from the perspectives of multiple employees. A first step is then to update the understanding of how factors of the Transformation 4.0 influence well-being.

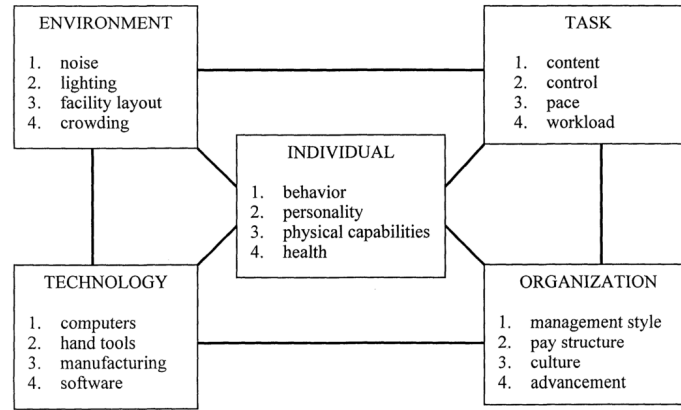


Figure 3.2: Working System Characterisation. 4 Categories and Example of Influencing Factors on an Individual's Well-being

### The Working System

To update this knowledge, let us start by identifying the specific environment in where the employee is located—the workplace. First ideas that come to mind are the nature of the employee's work and the way how this work is executed. The Working System, as illustrated in **Fig. 3.2**, provides the platform for this exploration. Here, the employee is at the centre of the environment and is surrounded by working elements of four categories: Task, Technology, Environment, and Organisation. This characterisation was originally proposed by Smith & Sainfort [56]. Its original use was for exploring factors that create stress upon employees. The work was later adapted and applied to working environments in where computer interaction was studied [3]. This draws a parallel with our study in looking closer at human-technology interaction in the workplace. The seminal work by Kaplan (see **Fig. B.1**), as adapted in [52, p. 8], and that by Bostrom & Heinen (see **Fig. B.2**) in [57, p.17] support this characterisation. They too explore how factors influence the stress state of an individual. The Working System remains relevant in contemporary literature for the study of well-being at the workplace [58].

Employees exist in a work system applicable to various industries. Depending on the job, tasks and technologies vary, but they all have an effect on well-being [3]. This is the premise of the Balanced Theory [56]. Employees experience the effect of factors and this triggers human response mechanisms that compensate and maintain a balance. However, these elements may be intensified and compensation may not occur, which ensues in a well-being imbalance. When control over factors lacks, adverse psychological and physiological reactions occur—this is known as stress. As time passes, the stress loading may lead to mental and physical fatigue, which for a prolonged time results in strain. This strain may take the form of physiological arousal, somatic complaints, especially of the musculoskeletal system, through mood disturbances as fear and anxiety, to overall decrease in quality of working life [3]. **Fig. 3.3** depicts this interaction.

### Work System Review: Categories and Factors

This study reviews factors particular to the four categories of the working system. Note that in **Fig.3.2** there is a fifth category, Individual. This is also reviewed in the study and refers to unique characteristics of the employee that influence and modulate how factors of the other categories are perceived and processed. These are personal factors which include physical health status, personality, past experiences, skills, goals, needs, and social situation [56].

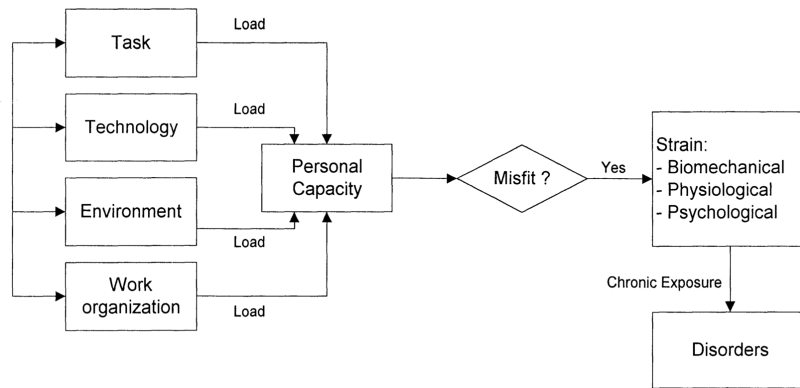


Figure 3.3: Balance Theory Depiction. Working System Loads on Individual may lead to Imbalance resulting in Stress and Strain

The literature review indicates various factors pertaining to these categories. The literature covered spans the following disciplines: Organisational Design [54, Table I, p.591], Human Resource Management [53, Table I, p.297], Ergonomics & Work Design [52, Table 2, p.15] and [59], Governmental Work-Place Research [60, Table I], Health Services [61, Additional File TICD Checklist], and Psychology [47, Table S1].

A summary of the factors is included in **Appendix B.2**. The relevant factors considered for this study are indicated below in the answering of SRQ1. The reader may consider an overlap between some of the factors. For instance, **leadership** is included in the category Environment as the quality of relationship between employee and supervisor; but it is also included in the category of Organisation, here as a mechanism to control and encourage leaders. This distinction could start a discussion on the concepts of hierarchy, supervision, and leadership. However, this reviews does not aim to define factors, but simply to indicate an initial set of factors that may influence employee well-being.

### 3.3 Answering SRQ1

The first sub-research question as specified in **Section 1.2** is:

**How can employee well-being be explored in a company?**

Well-being can be explored in a company through the categories and factors of the Working System. The complete list of factors and their definitions, as output of the literature review, is included in **Appendix B.2**. The complete list is relevant to companies in general. For the case of the associated company, this list is narrowed down to 16 factors. These factors are used in the preparation of interviews and their analysis. The selected relevant factors are presented in **Table 3.2**.

The knowledge on these initial factors bring value to practice in that they trigger a managerial reflection on their existence inside the organisation. To illustrate this reflection think of the factor Career Development; this can be defined as the long-term vision on employee's development, promotion opportunities and career paths. A manager thus inquires what efforts inside the organisation are addressing these elements and how they are changing due to new projects and new demands from employees.

Similarly, Task Identity can be defined as the extent to which an employee's work contribution is identifiable at the end of a process. By reflecting on the factor, a manager can make sure that more attention is paid to the recognition of effort by an employee, in the case that this employees is not able to recognise his or her work contribution in final products and services. Obviously, the opposite does not suggest that employees who work with products with clearer contributions should not be recognised for their efforts. The point is: by reflecting on the factor, well-being is present and thus more central in the decision-making.

Table 3.2: Selection of Relevant Factors of the Working System for the Exploration of Well-being in an Organisation

Category	Factor
<b>Organisation</b>	Career Development and Training
	Compensation and Reward
	Inclusive Management Practice
	Monitoring and Feedback
	Organisational Culture
<b>Environment</b>	Team Communication
	Supervision & Coordination
<b>Technology</b>	Design
	Implementation
<b>Task</b>	Variety
	Workload
	Complexity
	Identity
	Autonomy & Dependability
<b>Individual</b>	Uncertainty
	Job Engagement



### 3.4 Industry 4.0

Today's most embraced view on the fourth industrial revolution is that of the Industry 4.0 (I40). This is a strategic initiative launched by the German government in 2011. Around the world, similar efforts are the Smart Manufacturing Leadership Coalition in the United States and Made in China 2025 in China [15], for example. This visionary initiative encompasses the industrial trends of value chain integration, digitisation and increased automation [26]. Aligned with this study, Industry 4.0 raises questions on the impact of digitisation and increased human-tech interaction on employees [62, 14]. This section connects the human-centrality of the Working System to the Industry 4.0. With this, further context to the study of well-being is given.

However, is Industry 4.0 with its increased automation not an antithesis of well-being centrality? In fact, increasing automation comes as an opportunity for companies [3] as it allows them to:

1. ...increase product quality and conformity;
2. ...improve production time;
3. ...build a more flexible production systems to meet volatile market needs;
4. ...rely on more efficient machines that allow reduction of production costs, including personnel reduction.

The future vision, indeed, resonates with the first three reasons. It is true that demand rapidly changes and companies face the urgent need to increase flexibility and re-configurability of their production systems. They are increasingly requested to produce high-quality, mass-customised products with multiple variables in a more effective manner [63]. The contention, however, is found around the fourth reason. The I40 vision is not that of worker-less production facilities as in the 80's. At that time, with the evolution of the computed integrated manufacturing the future was that of lights-out manufacturing. This never materialised as machines were not able to manage all scenarios of flexibility and complexity. Humans are simply superior in working with unplanned tasks. The I40 vision does not *yet* present this scenario and, in contrast, it puts operators as the most flexible and agile elements of the system [64]. In the context of well-being centrality, the concept of the Operator 4.0 emerges. The vision does not welcome automation for the sake of substitution and more efficient work; instead, automation for the sake of the enhancement of human capabilities [63].

#### 3.4.1 I40 Context

If the I40 is not exactly a threat, what possible concerns may it bring? The literature review suggest 5 Areas of Concern. These are not exhaustive, but in the scope of the review they are found to be representative to provide an initial context to the I40 transformation. **Table 3.3** indicates the 5 Areas and these are explained in the paragraphs below.

One could argue that there are additional concerns as the need for standardisation, the need for novel research on cyber-security and personal data protection, and the need for an up-to-date regulatory framework [62]. These concerns, however, are not considered as they have a more technical nature and fall out of the social scope meant in this introductory review.

Table 3.3: Output of Literature Review on Industry 4.0: The 5 Areas of Concern

Areas of Concern		Reference
<b>A1</b>	<i>Need to review organisational structures and working processes</i>	[62]
<b>A2</b>	<i>Need to advance employees' skills, including forms of leadership and corresponding trainings</i>	[5]
<b>A3</b>	<i>Need to review strategies to encourage employees' intrinsic and extrinsic motivations</i>	[65]
<b>A4</b>	<i>Need to socially innovate towards an ease of the technology adoption process</i>	[14]
<b>A5</b>	<i>Need to enable an adequate environment for a more diverse and flexible workforce</i>	[66]

Regarding A1, the scenario of increased machines in the workplace puts pressure on maintaining the employability of people. This demands organisations to ensure that education structures are reviewed and new trainings offered. Employees should be able to combine more education with their constant flow work. In terms of other structures, the organisation need also pay attention to the evolution of team-work and supervision, including forms of leadership, as these may all become purely virtual. Does current structures readily allow for virtual sharing?

Concerning A2, I40 employees interact more often with robots and their collaboration may come in the form of monitoring, which is expected to make employee decision-making a more decentralised process. Decisions are then situational and employee responsibility increases. This implies a more knowledge intensive work demanding newer and more advanced skills [65]. Besides, tasks become shorter in execution and harder to plan, which demand to readily reach out to colleagues for cooperation and to be more proactive in anticipating and investigating problems. Skills go beyond technical to include more social and methodological. Forms of work in general are re-defined [5].

As for A3, the organisation should do more to understand the evolution of employees' motivations to join the I40 change. This also refers to convincing people that the new technology for their practice is meant to be beneficial. If hesitation on the benefits exists, the organisation should look into why this is believed and either rethink the perceived benefits or do more for creating the *psychological matching* [67]. Here, communication and leadership play a chief role in bringing the message across the company. Leaders should raise technological awareness across levels and when needed dive into smaller units for understanding more of the context. For example, what is the *technical literacy* of certain employees, that is, how they actually feel with respect to new technologies. Adapting change based on their background and motivations ensures the acceptance of change and the sustainment of the transformation, so that it achieves its developmental role [67].

With regard to A4, in order to lighten change the focus goes beyond understanding the employee's motivations. Knowledge on the technology and the process is needed. However, knowledge on possible impact on process can be limited. Take the case of automation which supports rapid, complex computations, and reduces excessive workload. Does the new technology make the employee relinquish control over the system? The higher the level of automation, the less control to exercise discretion. Owned elements of knowledge are not requested from the employee and this may lead to a monotonous work resulting in reduced job satisfaction. Not considering the possible impact is also risky, as the system situates employees out of the loop and their ability to diagnose and correct unexpected faults is impaired [68]. Easing the adoption entails a light introduction with communication and leadership, and an agile modification of the process when unforeseen consequences arise.

Finally for A5, the increased ageing population is a pressing issue in the European context. To remain competitive and ensure the industrial future of Europe [62] the value of generational diversity should be harnessed. Organisations should make efforts to adapt workplaces for employees of varying ages, experience levels, and health conditions. It is estimated that in 2025, in the original 15 European countries of the Union, the proportion of 50 to 64-year-old in the workforce will be doubled compared to workers younger than 25 years (i.e., 35% versus 17%) [69]. Some limitations of older employees include: slower learning and limited training capability; lower productivity and less working flexibility; low adaption to new technologies; and decrease of motor, visual, and cognitive functions [70]. However, in the I40 industry this is not necessarily a culprit. One can envision machines with different patterns of response to the varying workloads. When control and effort is high, the employee is fully effective. Though, as work progresses, effort remains high and operator's anxiety increases and control decreases, hence the *smart* machine adapts. By collecting data on the employee's profile, it responds to flexible demands and unpredictable situations [66].

### 3.5 Answering SRQ2

**What social concerns of the Transformation 4.0 may impact the employee well-being in a company?**

The literature review of Industry 4.0 indicates 5 Areas of Concern. They suggest a need to review organisational structures, training and recognition programs, technology adoption processes and the creation of a flexible working environment. Because the concerns follow from the broad industrial trend, they are assumed to apply to companies in general.

Not addressing these concerns may bring about working conditions that are not favourable to employees and that may impact their well-being. So, what specific factors influencing well-being may be connected to these concerns? The 16 selected factors indicated in SRQ1 are connected to the areas in **Table B.5**. Their connections are articulated through reflection questions.

For instance, A2 suggests a review on training programs and the indicated factor is Career Development & Training. The connection is articulated through the following question, how current training forms reflect the various learning preferences of users? In the case of Organisational Culture, the factor is connected to A4 and a germane question is, how does cultural values encourage a positive employee attitude towards new technologies? In **Appendix B.2.7** all reflection questions are presented.

In the table each factor is linked to two areas; a number 1 and 2 show these connections. A number 1 indicates a prominent connection, and 2 a secondary. The ranking is based on the clarity of the connection as considered by the author. These connections have also been validated with people inside the company. Note, however, these are not absolute connections and, arguably, factors may be connected to more areas, or to different ones. The links are non-exhaustive and, due to the project's scope, a maximum of two are specified. They simply present an initial case to answer the SRQ2. The concerns can be linked to well-being factors, therefore, by addressing the factor one can address well-being in the context of Transformation 4.0.

Table 3.4: Connections between Well-being Factors and the 5 Areas of Concern of Industry 4.0

Category	Factor	A1	A2	A3	A4	A5
<b>Organisation</b>	Career Development & Training	2	1			
	Compensation and Reward	1				2
	Inclusive Management Practice	2				1
	Monitoring and Feedback	1			2	
	Organisational Culture	2			1	
<b>Environment</b>	Team Communication	2	1			
	Supervision & Coordination	2	1			
<b>Technology</b>	Design				1	2
	Implementation			2	1	
<b>Task</b>	Variety		2			1
	Workload			2		1
	Complexity		1		2	
	Identity			1	2	
	Autonomy & Dependability	1		2		
	Uncertainty		2		1	
<b>Individual</b>	Job Engagement			1		2

## 3.6 Responsible Innovation

In recent years Responsible Innovation (RI) has gained popularity in policy-making and academic circles. According to the European Commission [as cited in [71]], RI aims to do science and innovation co-jointly with society and as intended for society. It can be seen as a tool, a meta-framework, or an umbrella term for activities aimed to enhance the innovation process of science and technology. For a rich introduction to RI including a historical account, please see the work of Owen et al. [72] and Stahl [73]. The exploration of RI in this review focuses on the main characteristics of the concept, its motivations and connections to other theories, and finally on its use in practice.

### 3.6.1 The RI Concept

Firstly, in addition to the concept of Responsible Innovation other scholars also use the term Responsible Research & Innovation. In this review both terms are unified and RI is used interchangeably. Strictly speaking, the distinction follows from research being based as an activity of epistemic significance, whereas innovation as that of value creation for commercialising products and services [74]. As the case in this thesis is chiefly based on a company, research can be defined as a *de facto* activity in the innovation process preceding the product commercialisation.

Responsible Innovation, according to its most widely used definition [29, p.9] is a “transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the ethical acceptability, sustainability, and societal desirability of the innovation process and its marketable products, in order to allow a proper embedding of scientific and technological advances in society.” In short, by increasing engagement with stakeholders, innovators can provide society with technological solutions that are more aligned to their needs and desires.

### 3.6.2 Motivation of RI

The first motivation for RI is to make better decisions on the uncertainty of technology through the active engagement of actors inside and outside the organisation [73]. New technology has the risk of unintendedly bringing negative impact on society. Technology consequences cannot always be predicted and, for the moment technology has already permeated the economic and social fabrics, reversing and modifying it may be too costly and difficult. This is the dilemma of control as articulated by Collingridge [as cited in [36, p.25]], “when change is easy, the need for it cannot be foreseen; when the need for change is apparent, change has become expensive, difficult and time consuming.” RI is then presented as an additional resource for organisations to improve the quality of their debate.

A second motivation for RI suggests the need of a new form of governance, one that allows organisations to be more responsive to society needs. A governance that easily sets the direction and modulates the trajectory of technology [72]. The new governance goes from reactive to proactive. Organisations should have the capacity, the mechanisms to deliberate and reflect upon the implications of their new technology programs, before and after. This is not suggested as a one-off stakeholder engagement, but as part of their institutional responsiveness.

### 3.6.3 Connection to other Theories

Improving foresight capability, working towards a more responsive governance, and increasing participation in technological innovation is not new [72]. There are other activities linked to RI in literature which include public dialogue, risk assessment, technology assessment, foresight activities, midstream modulation and other forms of community engagement [75, p.93]. For some, however, RI is an evolution, a modernisation of past theories [74]. RI does not replace approaches on technology ethics, rather, it maintains and coordinates them [30, 71]. As a matter of fact, RI is inspired by these other attempts. Technology Assessment, for instance, is mostly used as a philosophy for RI, a rationale behind encouraging engagement activities. RI revisits it and encourages its use among tech-developers, other experts, and actors [76].

### 3.6.4 RI Framework

RI is brought to practice through the framework by Stilgoe et al. [30, p.1573]. This framework comprises 4 dimensions and indicates activities related to each of them.

1. **Anticipatory**: to explore in advance potential technological impact. Anticipation refers to an organisation's foresight capability. How does it anticipate desired and non-desired outcomes of innovation? Horizon scanning and future scenarios techniques are some its activities.
2. **Reflexive**: to examine goals and purposes of technologies as well as the uncertainties in risk assessment. Reflexivity refers to questions on the underlying motivations of a project, areas of risk and the lack of knowledge. Collaborating across units in developing new trainings, situating external colleagues in other practices are indicative activities.
3. **Inclusive**: to consider the views of diverse stakeholders during design processes. Inclusiveness, or Engagement, refers to the process of ensuring that the technology dialogue includes various perspectives. Focus groups and open innovation are activities that broaden this engagement with actors.
4. **Responsive**: to alter and shape the original technological trajectory in response to deliberation and reflection. Responsiveness relates to organisational mechanisms that, based on the input from previous dimensions, trigger action when needed. Techniques in here include regulations, policy, and stage-gates.

As an extension of the framework, Stahl and Coeckelbergh [71] suggest the 4P's. These allow for a more concrete evaluation of the dimensions in the framework. For example, regarding anticipation one may ask—is the selected process methodology accepted by A or B actors, as well as the final product?

1. **Process** focuses on activities core to the research and innovation, including data collection, analysis, and validation;
2. **Product** includes products and services, and looks at the consequences of their use or misuse upon the natural and social environment;
3. **Purpose** focuses on the origin of the research—a need or an opportunity;
4. **People** focuses on the people, which are at the core of the concept.

### 3.6.5 RI Integration to Well-being

Based on RI indicative techniques and methods [30, p.1573], the dimensions of the framework are linked to work in literature of employee well-being as considered by the author. These examples are not exhaustive but may help the reader on the practical understanding of RI.

- **Human-Centred View, or Anticipatory:** The employee should be prioritised over the system. Therefore, it should be anticipated how the system will fit the operator, instead of adapting the operator to fit the system [77]. Before jumping into the limitations of the employee, the possible limitations of the equipment should be first reviewed. Equipment optimisation, environment, and procedures prior to stricter selection, placement, and training.
- **Combination of Disciplines, or Reflexive:** Ahasan and Imbeau [67] suggest to harness the value of knowledge brought by other professionals as ergonomists. They can together with engineers and change consultants expand the reflection and reinforce the socio-technical aspects of change.
- **Increased User Involvement, or Inclusive** Smith et al. [3] recommend a more thoughtful design of technology by increasing employee participation and thus capturing more user requirements. Employee involvement should occur early, during, and at late stages of the process in order to ensure initial acceptance, sustainment, and continuity of change.
- **Agility of Leadership, or Responsive** Alimo-Metcalfe et al. [54] emphasise on active and respondent leadership. Responsiveness takes the form of: showing appreciation for initial efforts, reassuring of the benefits of change, guiding the group towards next stages, uniting across stakeholders, supporting culture creation activities, and taking action when things get off track.

### 3.6.6 Opportunities for Practice

Based on the literature used to define the concept, motivations, and framework, some of the acknowledged benefits to practice include:

1. **Mitigation of Unintended Consequences:** There is no guarantee of it, but enhancing views on a topic is likely to increase the robustness of a design. A more robust design allows, for instance, a larger control over product and service before a technological lock-in occurs. Thanks to the RI framework a more central reflection occurs on the mechanisms to anticipate and act on undesired consequences [72].
2. **Increased Reflexivity Individuals:** scientific investigation and specification of design options as processes are enhanced by including social and ethical considerations [78]. These are commonly not part of the process; researchers do not often use technology assessments or marketing studies in their decision-making. Modifying the standard practice is likely to provide insights into what makes projects more successful. This reflection also encourages managers of research environments to link social and ethical considerations with Key Performance Indicators (KPI). The increase in reflection and understanding of one's practice is said to improve the quality of communication with customers (e.g., a deeper knowledge of pros and cons of a product and process) [79].
3. **Organisation Alignment:** bringing social and ethical aspects to a more central discussion allows for further alignment of departments. For instance, the research group

identifies ethical aspects of their products, which are reported to the marketing group; these aspects are core to the organisational culture and can be utilised for external communication [78].

### 3.6.7 Obstacles for Practice

Next to opportunities, the RI concept has shortcomings for its use in practice. As mentioned earlier, most of the work on the subject comes from socio-ethical academic and policy-making perspectives. The context of its use is mainly on academic R&D environments, while innovation also emerges from commercial and industrial settings [36]. As indicated in [25, Table 1, p.152], a few obstacles are:

1. **Diversity of Stakeholders:** involving many stakeholders may increase and enrich the view on the technological design, but in practice this may become a bottleneck owing to the different visions, goals, motives, conflicting world-views and value systems. In addition, this brings the difficulty of aligning responsibility between actors for unintended consequences—was the fault of the designer, the project manager, or the whole team?
2. **Information Asymmetry:** Not everybody shares the same level of information. Organisations retain information in the interest of competitive advantage. Through Intellectual Property they avert the leakage of valuable knowledge. Full transparency on new technologies and projects is risky from a business perspective. Additionally, lack of information implies lack of control of certain factors. During a negotiation, third parties may use this extra information to their advantage.
3. **Inherent Uncertainty:** The problem does not follow from the non-inclusion of views, but from the insufficient knowledge on possible outcomes. Despite anticipatory efforts, stakeholders may also lack the knowledge on possible undesired scenarios. This alludes to the wickedness of addressing sensitive ethical and social problems, namely, such subjects are open to interpretations of many actors who may not agree on the foundations of the problem.
4. **Resistance of People:** People may oppose change due to personal beliefs on the role of technology, but also due to convenience as structures and processes do not support the new form of work. On the personal reason, consider the effort needed to instil in technically minded people a reflection on the ethical aspects of their job. This may be challenging as they are not used to reflecting on these 'light' social aspects—truly, an *ethical epiphany* for them [Denzin as cited in [71]].



### 3.7 Answering the SRQ 3

The third sub-research question as specified in **Section 1.2** is:

**What does a Responsible Innovation approach suggest with respect to the Transformation 4.0?**

The answer follows from the RI Framework and its Integration to Well-being as described in sections above. RI suggests the consideration of four dimensions in the design and implementation of a new technology. In the case of the Transformation 4.0, these dimensions should be used for the improvement of the current practice and design of a new one. RI is suggested as a **lens containing four dimensions**, or criteria, through which the organisation can observed and study the practice.

The four dimensions are **Anticipatory**, **Reflexive**, **Inclusive**, and **Responsive**. They can be practically interpreted in the following way:

- Anticipation refers to the exploration of desired and undesired consequences of a new working practice; the exploration has a human-centred view instead of a pure process-focused one.
- Reflexive refers to the critical questioning of the motivations and risks of the new practice; bringing together different views allows for addressing more angles on the design process.
- Inclusive refers to user involvement at early, intermediate, and late stages of projects for their active input.
- Responsive refers to the actions taken based on the urgency from previous dimensions. Structures and resources which should be in place for taking action upon the practice. An example flexibility of leaders to move through hierarchy and modify a change project.

# Chapter 4

## Results: Corporate Case

This chapter has 4 sections and it presents the corporate case that gives the practical context of this study. The description of the context is based on documentation analysis and 9 interviews to employees. **Section 4.1** introduces the company; **4.2** indicates procedure, sampling and limitations of data collection; **4.3** and **4.4** give the highlights of the interviews from the larger functions and the selected units; and **4.5** concludes the chapter with the answer to the SRQ4.

<b>Section 4.1</b> Case Introduction	<b>Section 4.2</b> Data Collection	<b>Section 4.3</b> Results: Organisation	<b>Section 4.4</b> Results: Units	<b>Section 4.4</b> SRQ4
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### 4.1 Introduction to Company

#### 4.1.1 GOPS Background

The study was conducted on-site at the Global Operations (GOPS) corporate function of the associated company. GOPS' range of activities is extensive as they build and manage the company's supply chain. GOPS divisions range from Indirect and Product Procurement, through Manufacturing and Process Automation, to Delivery and Stakeholder Management. These divisions are supported by other departments as HR, Legal, IT, and Finance & Control.

Specifically, the student-researcher joined the Strategy Development group. This groups cares for GOPS' strategy needed for the Transformation 4.0. Governance development, projects coordination and communication are some of their capabilities. Moreover, they maintain the overview of digital projects that are being gradually deployed across divisions. This requires them to capture knowledge from projects, share it across units, and recommend actions for the direction of the GOPS function.

#### 4.1.2 Transformation 4.0

The transformation in the company extends across divisions. Due to the scope of the study this is limited to GOPS' Central Functions (HR, Change Management, Leadership & Talent) and 2 technical units, hereinafter called Unit A: Business and Unit B: Factory. The selection of these units is based on number of ongoing digital projects, accessibility of data, availability of contact people, and internal priority. The organisational and technical units are relevant

for the study as they have a strong focus on the people factor and they are currently busy with change from new digital projects.

The selection of the units and guidance is provided by the **Supervisory Team** inside GOPS Strategy Group. The project does not have a fixed request and the main practical boundary is the project background and need. Namely, how current structures are being modified in light of the vision Industry 4.0. Concretely, this vision or model presents two Modes of Operation for the company: Mode 1 and Mode 2 as shown in **Fig. 4.1**. The former is the existing, incremental, operational business in the company. The latter is the exploratory, potentially radical, not-yet operational business meant to identify new, value-creating tools and processes.

Mode 2 contains three stages: Exploration, Proof of Concept (PoC), and Proof of Value (PoV). In the first exploratory stage projects possibilities are identified, these may include novel technologies. These candidates go then through an assessment that determines their feasibility (PoC) and value to the company (PoV). Mode 1 is the actual implementation stage, in where feasible, value-proven projects are transferred to business units for their subsequent implementation. Mode 2 is driven by small working groups; Mode 1 may include various groups across the company. In Mode 1 new technology is brought to the workplace; during Mode 2, the new project with new technology is only exposed to a limited number of testing groups and to those driving the projects.

It is in the interest of the company to use the time during Mode 2, to communicate and prepare people for possible change. Otherwise, as literature and practice suggests, the change may be too abrupt and new projects may meet considerable employee resistance. How current practice increases and lightens technology adoption is one of the background corporate questions that motivated this study.

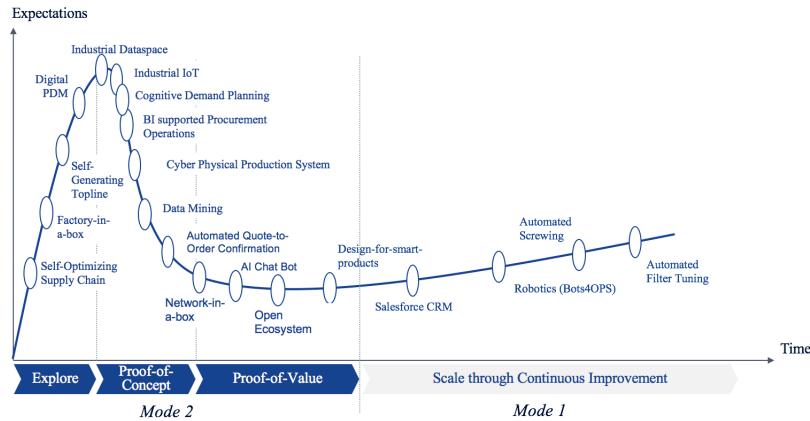


Figure 4.1: Company's Mode of Operations: Innovation Funnel recommended by Gartner Consultants for use in Nokia GOPS

## Transformation in Business and Factory Units

Before completing this section, a few comments on the two technical units are given. Details on digital projects are omitted due to corporate confidentiality.

The Business Unit forecasts the demand of products based on the real-time analysis of markets input. Transformation in this unit includes 12 projects meant to increase integration of internal functions, integration of business offers, increase quality of planning, and automation and analytics aspects. Specifically, 2 projects of this unit were selected: one recently initiated project on Demand Sensing and one completed project on Inventory Optimisation. Both projects follow from the high demand volatility of markets, the high product

variance, and the shorter lead-times of orders. For both, automation is a key enabler but in different roles. For one project automation is traditional as it takes over repetitive tasks performed by employees. For the other, automation is more progressive as it entails complex decision-making tasks for identifying new business trends and anticipating risks and opportunities.

The Factory Unit produces telecommunication equipment and is the biggest manufacturer of this type in India. Their transformation includes 40 projects, which are concurrently done with the execution of standard tasks. Automation is directed to the predictive and preventive capability of machinery; to the system's ability to flexibly and efficiently step-up or step-down production; and to the capacity to save energy and reduce resources. Digital projects in this unit include the of Virtual and Augmented Reality, Autonomous Vehicles, Health and Control Wearable Devices for operators to name a few. Despite increased automation, operators continue to play a key role in the factory. More information on factory efforts on well-being are included in **Appendix C.1.2**.

## 4.2 Data Collection in Company

### 4.2.1 Interview Procedure

The data collection execution is depicted in **Fig. 4.2**. Step 1, 3, and 5 are for preparation and analysis; and step 2, 4, and 6 are for direct contact with the 9 interviewees. **Step 1** is the first contact point with employees inside the organisation; here, the project is introduced and their collaboration requested. **Step 2** and **4** (or **Round One** and **Round Two**) are the actual interviews, either face to face or by video-conference; these are executed following the interview protocols included in the **Appendix C.2**. In **Step 3** and **5** the results of the interviews are processed and analysed. Between interview and analysis, Moments A and B take place; these are, triangulation points in where the interviewees validated the author's right interpretation of their answers. This moments include a discussion with the supervisory team on project findings thus far and subsequent planning. **Step 6** is the decoupling point, in where findings and recommendations to the company are discussed and shared back with participants.

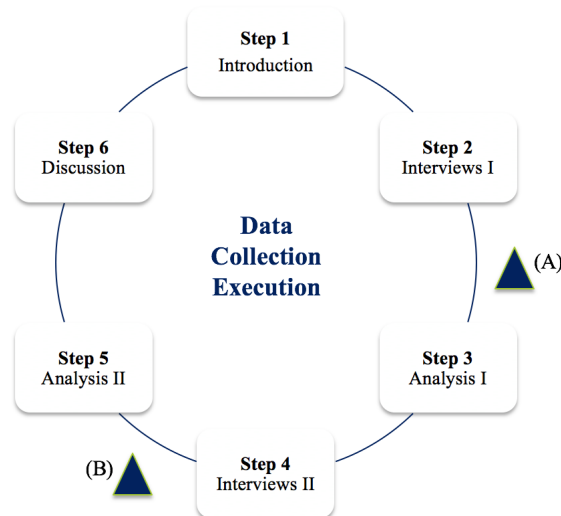


Figure 4.2: Company Case Study: The 6 Steps of Data Collection Execution

### 4.2.2 Interview Sample

9 employees of the company are contacted for the interviews. The sample includes people from large organisational functions (n=6) (i.e., Human Resources, Change, and Leadership & Talent groups) and from 2 technical units (n=3) (i.e., Unit A: Business and Unit B: Factory). **Table 4.1** presents an overview of the interviewees and their area of work. 4 interviews are conducted face-to-face in the GOPS' location in Germany. The other 5 interviews are conducted via video conference with interviewees in Finland, Hungary, and India. The selection of the interviewees is assisted by the supervisory team and motivated by the working role of the employees and their exposure to current transformation projects.

Table 4.1: Company Case Study: Overview of Interview Sample

Section	Interviewee		Department	# Contact Points
Organisation	$\alpha$	Alpha	Communications & Change Management	3
	$\beta$	Beta	Change Management	3
	$\gamma$	Gamma	Leadership & Talent Development	3
	$\delta$	Delta	Venture Management	2
	$\varepsilon$	Epsilon	Business Human Resources	2
	$\zeta$	Zeta		3
	$\eta$	Eta	Business Unit: Process Owners	3
Unit A	$\vartheta$	Theta		1
Unit B	$\iota$	Iota	Factory Unit: Head of Manufacturing & Team	3

### 4.2.3 Limitations of Data Collection

Interviews are not recorded and there is no literal transcription of the interviewees' answers. Instead, notes are taken during the interviews and these are later summarised and shared back with the participants (i.e., Moments A and B in **Fig. 4.2**). This verifies the right interpretations of answers.

A second limitation is that of the limited number of interviewees, nine people cannot provide a *representative* view of the large GOPS function, for their answers might simply be opinions, possibly biased. However, in the limited scope of the thesis, these 9 interviewees (approximately 3 contact points per participant) are acknowledged as relevant by the supervisory team and thus their selection. Many of the participants have extensive experience with transformation and they presently lead, or are actively involved in digital projects. Their oversight allows them to speak on behalf of other employees.

### 4.2.4 Coding & Documentation Analysis

The supervisory team and the interviewees provide from the beginning various documents explaining the structure of the organisation and its future vision. Besides, referral from interviewees includes links to the company's internal web-net, which is the entry point to a constellation of websites connecting departments and projects. In order to make sense of large sets of data, a content analysis is performed. According to Krippendorff [as cited in [80, p.108]], "content analysis allows for making replicable and valid inferences from data to their context with the purpose of providing knowledge, new insights, and a representation of facts." It is recommended to connect conditions, actions and interactions that cause a phenomenon and its consequences on an abstract level, that of categories. With this, concepts can be studied for similarities and differences, this exercise is known as **open coding** [81].

The coding in this study supported:

1. The documentation analysis that gives answer to SRQ4 (**Section 4.5**);
2. The design of the interview protocols (**Appendix C.2**);
3. The analysis of interim results (or 4 Clusters of Inquiry in **Section 4.3.2**);
4. The specification of the 9 Areas of Inquiry and their analysis (**Section 5.1**).

The first part of the coding is based on the literature review outcome: the 5 categories of the Working System and the 5 Areas of Concern. The coding is done at the author's discretion and it is not documented in the report which is a limitation for its replicability. However, the coding follows from the factors of **Table 3.2**, which are used as keywords to be grouped under their corresponding category. For instance, a keyword used is Team Work which follows from the factor Team Communication and belongs to the category Environment; or the keyword Leadership which follows from the factor Supervision & Coordination also under the category Environment.

The second part of the coding is based on the 5 categories of Working System and it assists with organising and analysing the results. How the highlights of interviews are presented in the next section, and how they are discussed in the next chapter are based on this coding. Clustering findings based on some of the Factors is done at the author's discretion. The findings are presented in **Table 4.2**. These clusters are hereinafter named the 9 Areas of Inquiry.

Table 4.2: Guiding Coding for Connection of Areas of Inquiry to Well-being Factors

Categories	Areas of Inquiry	Well-being Factor
<b>Organisation</b>	Learning Pillars	Career Development & Training
	Recognition and Visibility of Expertise	Compensation & Reward
	Interaction with External Actors	Organisational Culture
<b>Environment</b>	Transparency of Change Learning	Inclusive Management Practice
	Leadership Capability	Supervision & Coordination
<b>Technology</b>	Change in Implementation	Technology Implementation
	Continuous Improvement Capability	Monitoring & Feedback
<b>Task</b>	Concerns on New Forms of Work	Technology Design
<b>Individual</b>	Professional Identity	Job Engagement

## 4.3 Interview Results: Organisation

### 4.3.1 Highlights of Interviews: Round One

The first interview (**Step 2** in **Fig.4.2**) contains 13 questions that can be found in the interview protocol in **Appendix C.2**). Not all answers are documented in this section and the selected few bring forward insightful remarks, which connect with well-being factors, allow the evaluation of the current practice, and suggest actions towards its improvement. As stated, answers are clustered for their reporting based on **Table 4.3**.

Table 4.3: Presentation of Results based on 9 Areas of Inquiry

Categories	Areas of Inquiry
<b>Organisation</b>	Learning Pillars
	Recognition and Visibility of Expertise
	Interaction with External Actors
<b>Environment</b>	Transparency of Change Learning
	Leadership Capability
<b>Technology</b>	Change in Implementation
	Continuous Improvement Capability
<b>Task</b>	Concerns on New Forms of Work
<b>Individual</b>	Professional Identity

#### Organisation

##### 1. Learning Pillars

- ( $\delta$ ) It is important to focus on new learning material, as well as on traditional methodologies as Lean and Six Sigma (among others). These have proven valuable inside and outside the organisation and should not be undermined as they remain relevant.

##### 2. Recognition and Visibility of Expertise

- ( $\gamma$ ) Some employees may not know about expertise outside their working units. Knowledge may remain contained in the unit and inaccessible to others.

##### 3. Interaction with External Actors

- ( $\delta$ ) Consultancy firm enables interactions with external partners from industry network. Other connections follow from previous businesses experiences or group's and own individual interest.

#### Environment

##### 1. Transparency of Change Learning

- ( $\alpha$ ) Change learnings may not be transferred across divisions. They may be exclusive to certain groups and may not be available to smaller groups.

- ( $\beta$ ) Change learnings are communicated on a larger level that may not relate to activities of smaller groups. Namely, volume and language of change may not be practically applicable. Managers of small groups may be encumbered to *translate* learnings into practice. In addition, sharing in virtual teams occurs often but to various degrees of impact. There is not a common methodology to embed shared learnings.

## 2. Leadership Capability

- ( $\beta$ ) The understanding of what it means to be a project sponsor, leader, change agent differs across actors.
- ( $\gamma$ ) Leaders are instrumental in facilitating employee professional development.

## Technology

### 1. Change in Implementation

- ( $\beta$ ) It is not clear the exact way how employees give input on tool and process development at early stages. The project management methodology recommends certain steps but managers ultimately decide on specific actions. Training for new tool and processes may be executed at late stages of the project.

### 2. Continuous Improvement Capability

- ( $\beta$ ) There may be a strong reliance on the Continuous Improvement (CI) function. Limitations on tools and processes *should* be later addressed by CI.

## Task

No applicable input was given. More information on this topic was obtained in the second round of interviews.

## Individual

### 1. Professional Identity

- ( $\alpha$ ) People tend to have a fixed professional identity. Modifying or developing a new one is very difficult. Professional identity includes skills and the ways how one works. An interesting remark is that of addressing the taboo around sensitive subjects as changing company, steering career path, and retiring earlier.
- ( $\delta$ ) Training and communication on learning opportunities motivate people to work their professional identity. However, the emphasis is also on the employee's responsibility to develop his or her employability.



### 4.3.2 Intermezzo – Four Clusters of Inquiry

The input given in the first round of interviews allowed the formulation of the following clusters of inquiry. These form the conversation subjects that guide round two of interviews (Interview protocol to be found in **Appendix C.2**).

1. The alignment of departments to strategise and provide development resources to employees, including training capable leadership.
2. The inclusion of change management aspects in early process stages, including involvement of users and interaction with external sharing practices.
3. The sharing practices across groups and need for effective codification of learnings for enriching process methodologies across groups.
4. The view from reactive to proactive on the role of continuous improvement and their interaction across units

### 4.3.3 Highlights of Interviews: Round Two

#### Organisation

##### 1. Learning Pillars:

- ( $\Upsilon$ ) Traditional methodologies should be reviewed to fit the mode of operations of a given department. People think of these methodologies as exclusive to other departments (forms of operation). The mentality that the office cannot learn from other factory should be changed. A one time workshop would not ensure the use of these tools.
- ( $\Xi$ ) Digitisation (i.e., one's ability to work with computer-based systems and understand the computer language) should be presently treated as a *behavioural trait* and not only as a technical one. This would have implications for recruitment and employee education.

##### 2. Recognition and Visibility of Expertise:

- ( $\alpha$ ) Initiatives for increasing visibility across units and opportunities to connect with professionals from other disciplines have recently been launched. This is expected to encourage employees to discuss more openly career obstacles and other well-being topics.

##### 3. Interaction with External Actors

- ( $\beta$ ) Consultancy firms commonly give input to a central unit and this input is later transferred to change groups. This signals the need for the change group to also benchmark on its own as part of their internal competency creation.
- ( $\Upsilon$ ) Participation in external events and conferences may be primarily done by higher levels. This external feedback is processed by leaders and then transmitted to the rank and file. The captured external knowledge is not always visible to lower levels.
- ( $\Xi$ ) Intellectual Property knowledge may be a specialised knowledge exclusive to people from higher levels, those who consolidate ventures and other forms of external cooperation. It may be an absent knowledge to lower levels.

## Environment

### 1. Transparency of Change Learning:

- ( $\alpha$ ) Cooperation in education projects are currently in full swing. They entail complex responsibilities: platform used is owned by one group and training subjects and material are suggested by a different group; new leadership learnings are encouraged by one group, but formal leadership trainings are owned by a different one; similarly, survey to measure employee perception on change is owned by actor A, and execution and tailoring by actor B.
- ( $\beta$ ) The support by change groups is mainly directed to larger organisational aspects, including training plans and communications. When considering their support, the level of analysis should be specified—change for individuals, project groups, or organisational.
- ( $\epsilon$ ) PM methodology does not specify how learnings can and should be transferred to future projects. Once the results of a given process are known, the information cascades to other users, either in informal or formal forms. This methodology is owned by one small group inside the organisation and there is not much transparency into their actions.
- ( $\gamma$ ) Challenging the status quo and reflections on how things could be done differently may commonly be received as a form of criticism. Reactions may tend to be defensive demanding from the messenger a clear solution to the problem.

### 2. Leadership Capability:

- ( $\beta$ ) Employees often find themselves troubled to develop their career not because of task and technology difficulty but because of poor relationship with their bosses.
- ( $\epsilon$ ) Line managers decide to a large extent what to include in the execution of the projects they lead. Interaction between line managers and change experts may not occur. Commonly, change aspects may only relate to communication.
- ( $\zeta$ ) Protectionism may be weakening cooperation across units. Leaders seek to protect their own seeds in pursuit of recognition.

## Technology

### 1. Change in Implementation:

- ( $\alpha$ ) Stakeholder involvement in early phases of a project may be limited to the one-off obtention of users' technical requirements. Change 'social aspects' are not be explicit in the project management methodology. Having said that, next to ensuring the right methodology, employees should also take action for ensuring one's well-being.

## Task

### 1. Concern on New Forms of Work

- ( $\beta$ ) Future scenarios are currently blurry as to what future roles will entail. Many tasks may be unforeseeably altered and employees will be rendered supervisors, spectators of a machines' task. To what exact purpose am I still needed? may trouble employees.

- ( $\epsilon$ ) A main concern is the increase decision-making ability and coordination of information that will put pressure on employee's need for new skills.

## Individual

### 1. Professional Identity

- ( $\alpha$ ) There are existing programs encouraging employees to be more entrepreneurial. However, are these being communicated in all divisions?
- ( $\zeta$ ) Some employees still believe that software and computer knowledge can be *outsourced* to someone else; thus justifying their lack of knowledge, or willingness to learn.
- ( $\epsilon$ ) Job rotation should be understood as fluidity. This refers to opportunities to complement and build upon existing knowledge. Rotations should be planned carefully, lest a unit may end up with generalists when subject experts are also needed. Employees have sometimes valid reasons for staying in the same department. They aspire to climb the career ladder and doing so requires them to remain longer or only in that group. Further, fear is a less valid factor but relevant. Employees may not want to leave as they fear that upon return the process will be different, the line manager and team-members will be new. In a rather similar way, people are retained in a same unit as it is feared by line managers that particular skills may not come back.

## 4.4 Interviews Results: Units

### 4.4.1 Unit A: Business

The interviewees from the previous section provided a general perspective on the organisation. The answers reported in this section are project owners who have been working first hand with the technical aspects of new tools and new processes. Highlights of these interviews are not organised in two rounds. Many answers supported previous highlights, thus in the interest of brevity they are not repeated in this section.

## Organisation

### 1. Interaction with External Actors

- ( $\eta$ ) Certain project groups interact with external companies on knowledge sharing thanks to the mediation of a consultancy company. The consultancy firm serves as a broker to match projects and capabilities within their clients.
- ( $\vartheta$ ) Other project groups only interact with external companies for exploring and negotiating how a solution (e.g., design of new tool) can be achieved. This collaboration includes use-cases, in where the vendors determine users' needs and tool's functionalities. The technical know-how from external companies (e.g., consultancy) is not necessarily stronger than that of the internal group.

## Environment

No additional input was obtained from the interviewees.

## Technology

### 1. Change in Implementation:

- ( $\eta$ ) In addition to missing knowledge on technical aspects, the social aspects of a defined have not yet been addressed. The exploration is at early stage. Collaboration with other units is required to gather input of future tool. Valuable exchange has occurred but sometimes spontaneously without fixed planning.
- ( $\vartheta$ ) User involvement could be enhanced as traditional tool deployment is mainly top-down. It is key that employees stop and see where they are going and how the tool will assist; otherwise the process may be too in a hurry, and the new practice has old features that should not be there anymore.

## Task

### 1. Concern on New forms of Work:

- ( $\eta$ ) Main concern over new tools revolves around *trust*. The computer will deliver an output which needs to be accepted or rejected by employees. It is critical to understand why how the machine arrived to the output.
- ( $\vartheta$ ) Trust in the machine's output is acknowledged to be a concern. However, more concerning is the overall trust the employee would need to make the transition to the new tool and new style of work. People need to invest quality time into learning and mastering new tools.

## Individual

No additional input was obtained from the interviewees.

### 4.4.2 Unit B: Factory

This section presents answers from the interviews to the factory team.

## Organisation

### 1. Recognition and Visibility of Expertise:

- **Filter Tuning**
  - Regarding filter tuning (as key factory task and capability), operators who advance in their learning receive dedicated badges that indicate their expertise. This has two purposes: one, employee effort rewarded which is likely to increase work satisfaction. Two, operators in the work-floor know whom to contact when needed. Moreover, additional achievements by operators are displayed on the wall of tuners.
  - An additional motivation for operators to excel in their *handcraft* is the possibility they have to share their knowledge with operators from other factories. Depending on the product transfer, master tuners have been sent to factories abroad to learn and to give training to other people. A more recent motivation is that of providing the same training online, so that their work impact more people and can be repeated many more times.

- **Automatic Guidance Vehicle** Internal capability of maintenance group has been enhanced. This was influenced by the intrinsic motivation of employees to learn new aspects of their work due to maintenance of new machines.
2. **Interaction with External Actors:** Many stakeholders, inside and outside the factory, formed part of the technology implementation process. Despite the large number, managing stakeholders is a critical aspect (e.g., without safety group projects do not go further). In addition, benchmarking was indicated as a common practice.

## Environment

1. **Leadership Capability:** Leaders are key in convincing employees of the importance of new technology adoption. It is very important that they demonstrate with real cases how the future may look like. Instead of delegating, high level leaders make use of technology, a tele-presence robot to be there and inaugurate an even on the factory on the other side of the world. With this they gradually work towards creating a *tech trust culture*. They are also responsible to address any technology-related negative feedback from the very beginning.

## Technology

1. **Change in Implementation:**
  - Employees at all levels have been involved with the introduction of new technology. For example, all employees were requested to suggest names for the new Automatic Guidance Vehicles (AGV). In the interest of gender equality, these were introduced with one local male and female name. The managerial view on the machines was also peculiar, “They are not only machines, but employees. They have their own name and badge.”
  - In the case of the AGVs, the employees have understood clearly how technology contributes to their job. In the past operators walked 23 km pushing trolleys around the factory. Now, this is the machine’s task. It was thoroughly communicated to employees that this change is aimed at their well-being.

## Task

No additional input was obtained from the interviewees.

## Individual

1. **Professional Identity:** The practice at the factory has a strong focus on people. Despite increase introduction of new technologies, engagement surveys are said to show high levels of employee engagement.

## 4.5 Answering the SRQ4

The fourth sub-research question as specified in **Section 1.2** is:

**How does the associated company manage the impact of the Transformation 4.0 on employee well-being?**

**Section 3.4** indicated 5 Areas of Concern brought by the I40 vision. Recall these Areas suggest *a need to review*. **Table 4.4** presents internal activities in the company that address these Areas. The activities have been identified through the analysis of documentation in the company. **Appendix C.1** explains in detail what these current efforts entail. A summary is presented below.

Note these are not representative of all internal efforts. In the scope of the project, they are simply selected to provide **context to the investigation**. Their information was used for preparing, executing, and analysing the interviews. For instance, the review of the effort Project Methodology provided vast input on how change can be flexibly driven by managers, when is user involvement recommended, and through what exact stages a new technology project goes through inside the organisation.

Table 4.4: Current Organisational Efforts to address Social Concerns

Area of Concern		Current Effort
A1	Org. Structures	Digital Strategy
A2	Skills & Training	Education Platform
A3	Employee Motivations	People Focus
A4	Technology Adoption	Project Methodology
A5	Flexible Environment	Well-being Campaign

1. **A1 with Digital Strategy:** A review of new structures is encouraged by requesting bottom-up feedback and communicating top-down the vision and the required actions towards evolving the organisation.
2. **A2 with Education Platform:** A review of learning and training is underway by gathering input from the community. Education is based on an online learning model which flexibly accommodates various learning styles. Mandatory and voluntary learning address the reinforcement of traditional skills and new ones as Cyber-Security.
3. **A3 with People Focus:** A review of motivations is achieved by institutionalising contact points between employees and supervisors. This allows employees to take more ownership on how their work and career development. This triggers good relationship with team and larger organisation.
4. **A4 with Project Methodology:** Technology adoption may be addressed by the current methodology which works towards implementing technology effectively and efficiently. Social aspects are declared as part of the methodology.
5. **A5 with Well-being Campaign:** Diversity of workplace is addressed by encouraging a healthy community—applicable to all employees across units. Input is gathered on enabling an adequate environment for well-being, but also the responsibility and action from the employee side is requested. Campaign makes use of passive and active strategies to facilitate the transition towards a well-being culture: nurturing the values behind the behaviour and rewarding the exemplary behaviour.

## Chapter 5

# Discussion

This chapter discusses the findings of the corporate case against the theoretical framework of the study. It is divided in two sections. Firstly, the 9 Areas of Inquiry are explained and they are connected with the 5 Areas of Concern and with the 4 dimensions of Responsible Innovation. Secondly, the opportunities and obstacles for RI are presented; this answers SRQ5 and SRQ6.

<b>Section 5.1</b>
Discussion

<b>Section 5.2</b>
SRQ5   SR6

### 5.1 The 9 Areas of Inquiry

#### 5.1.1 Learning Pillars

This area connects with the **need to review new required skills for employees** in employees. The literature focuses on new and additional skills that future roles may require. The review inside the organisation should also be focused on traditional methods and learnings. These may include methodologies as Lean, Six Sigma, Kaizen, among others. **These are learning pillars that should not be limited to only a few groups.** People outside these groups may believe this knowledge is not applicable to their work and context; that they cannot learn from distant units as the factory. Trainings may have been one-off workshops which did not have a follow-up on how they could actually be used in daily work.

Employees presently face the pressure on job stability due to the I40 emphasis on new, unfamiliar skills. They are psychologically pressured if no attention is paid to their present elements of knowledge. Indeed, attention to new skills is needed, but the communication on the topic should not be *new or nothing*. Here, the **inclusive** dimension of Responsible Innovation brings its value. By **increasing user involvement**, traditional learnings can be mapped, reviewed, and adapted to fit other units. Employees can creatively contribute to naming examples from their experience that go beyond the typical lean-factory case. Their input should also address the difficulties of practice and preferred ways of learning.

#### 5.1.2 Recognition and Visibility of Expertise

This area connects with the **need to review strategies for motivating employees**. People need to be motivated to understand the urgency of joining training and achieving

more through their work. Motivation in here may come from the personal interest to reach out to other groups, as well as from official forms of compensation. Strategies should be reviewed to consider various types of collaboration and performance, in particular those of new digital groups.

Employees should receive **a clear demonstration of benefits brought by new projects**. Communication on the practicalities of change and how their efforts are rewarded should be clear. They should be reassured that the invested time in new learning and new ways of working bring benefits. Otherwise, they may learn by compliance. This is risky, as employees hardly assimilate the use of tools and it preempts tool-proficiency. The opposite, assimilation of learning, likely enables proficiency or dexterity. When the new learning and behaviour have been acquired and have led to positive business results, the employee should be duly rewarded, either financially or by other internal means of recognition. Being recommended for sharing their expertise to other units is a form of reward, which increases job satisfaction. Here, the **reflexive** dimension brings its value. **A review should also focus on how units currently exchange knowledge and how people seek expertise outside their groups.**

### 5.1.3 Interaction with External Actors

This area connects with the **need to review organisational structures and working processes**. Consultancy companies play a positive role when they connect the company to other actors in the interest of sharing knowledge. Projects that are stagnated due to lack of knowledge profit from these arranged sharing-sessions. However, reaching out should not be limited to groups in contact with the consultants. Other units should too seek external interaction, maybe not in the form of direct exposure to other companies, but at least in benchmarking as a form of looking outwards.

Employees with limited outward exposure may constantly deal with similar work. Monotony, the lack of newness, may impact the satisfaction derived from new tasks. Besides, they are outdated with respect to skills and knowledge brought by new trends. Here, the **inclusive** dimension brings its value. Attending and speaking at conferences may be other effective ways of interacting with the exterior, but not everyone can do this. **The internal capability of looking outwards should be built across lower levels and it should consider the various employee profiles.**

An interesting remark in here is that external interaction could also be restricted by the lack of knowledge on Intellectual Property (IP) This knowledge commonly belongs to people doing venturing and other corporate agreements. People from lower levels do not deal with this knowledge on a daily basis. The lack thereof makes them fear that in their external interactions they may leak critical information on new projects. This may also occur with project managers who limit the interactions of their subordinated colleagues as they may indeed leak some information. **Basic knowledge on IP may empower employees and their managers to look outwards more often.**

### 5.1.4 Transparency of Change Learning

This area connects with the **need to review organisational structures and working processes**. It is important to recognise the value of change management beyond its use in big organisational restructuring and change. **Change learnings should not remain exclusive to big-change level groups and should be brought more often to project**



groups and individuals.

Limited sharing could actually isolate the change group and valuable learnings for future projects not to run into past obstacles may not be shared. This connects with the **responsive** dimension as **managers should be able to access change learnings and swiftly adapt them to their ongoing projects**. Recommendations from change groups may not always fit the needs and demands of their groups. **The knowledge of large organisational change should be translated to lighter learning packages**. This also applies to learnings between groups, which may not always be documented, shared, and captured across units.

### 5.1.5 Leadership Capability

This area connects with the **need to review new required leadership skills**. Leaders have the critical task of recognising employee efforts and suggesting actions for employee development; they connect working groups; they drive change; and they act when projects do not go as planned. **Training in leadership should inform and prepare leaders on these various roles**. The understanding of these different forms of leadership may not be shared by all managers.

Here, the **responsive** dimension brings its value. It suggests trainings and communication to be up-to-date by the active gathering of input from leaders as to how leadership evolves across groups. An interesting example is that of sensitive thinking on the time-implications of new programs. Leaders should be responsive to the state of their project. They should not be too protectionists seeking compensation only for their own group, but they should know when to balance protection for their early seeds. Otherwise, others will say, “no that seed will not work”, due to lack of robustness.

### 5.1.6 Change Aspects in Implementation

This area connects with the **need to review the technology adoption process**. Leaders have a lot of flexibility to decide what change aspects are included during implementation of new technology. Thanks to this flexibility no unnecessary constraints are put on projects. However, if there is no common understanding on the importance of change aspects, valuable actions may be overlooked.

If these leaders and their view upon process is mainly technically-centred, the specification of requirements may overlook key factors for employee well-being (e.g., varying degrees of workload, diverse skills, and preference for modes of operation). This may result in a new yet unsuited tool for various types of users. Here, the **inclusive** dimension brings its value. **Change aspects as two-way communication and increased user involvement should be encouraged for more robust functional requirements**. There should be a review on how users are involved during the early stages of requirement specification, and also at later stages for the evaluation of unforeseen impact and the recommendation on how to sustain change in next cycles.

### 5.1.7 Continuous Improvement Capability

This area connects to the **need to review organisational structures and working processes**. Involving many users at the beginning and aiming for a thorough functional

requirement specification may be expensive. CI brings the opportunity to later correct and enhance the tool. Due to the inherent uncertainty of new high-tech projects, this is positive in that it impedes the stagnation of projects. However, diagnosing and correcting a problem at a later stage may not always be possible and it is expensive financially and from the employee's perspective. There should be a review on the basis and execution of CI, so people perceive it and utilise it as **a methodology in early design stages and normal operations**.

Here, the **reflexive** dimension brings its value. The work of the CI unit is very valuable. Employees acknowledge it, but they may perceive it as a central force capable of correcting and bettering daily activities. **Limited action in including social aspects at early stages may be partly justified by the CI-can post-ability to correct**. It should be striven to make tools from the beginning as robust as possible. CI should reflect how it supports both ends: early requirement specification and standard mode of operations. A reflection on the topic should also look closer at how CI learnings have been **decentralised** for projects groups to use CI in daily practice.

### 5.1.8 Concern on New Forms of Work

This area connects with the **need to enable an adequate environment for a flexible workforce**. The system should fit the operator and not the other way around. Within rational constraints, **user profiles should be mapped, so that the design of new tools is based on these diverse profiles**. This is particularly important in the design of tools used by employees in roles with high decentralised decision-making.

High self-confidence, quick rationalisation, and deep understanding of the core process are important attributes of these roles. Employees can be trained, but due to cultural and generational background, some may struggle in developing such profile. Here, the **anticipatory** dimension brings its value. The design for diverse knowledge and transparency follows from the anticipation of what those negative decision-making scenarios may be. In the case of the company, trust in machine's output was foreseen to be a critical yet abstract factor. This should be specified in the design of the tool and the description of the new form of work. In the tool, it may be specified as the user's ability to verify information given by the machine, say, with the transparency of algorithms (i.e., the rationalisation process that the machine followed to provide that answer). In the form of work, it may be specified as the operator relying on software, documentation, or the support by other colleagues. Uses and misuses should be anticipated and addressed in a similar way.

### 5.1.9 Professional Identity

This area connects with the **need to review strategies to encourage intrinsic motivation from employees**. People should be assured from the organisational side that change does not mean a deconstruction of their professional identity. There should be a review on how to trigger the self-interest of employees to step out of their comfort zone and take action on their career development.

This links with the **inclusive** dimension. Here, **a mapping of the multiple, current motivations behind employees' efforts should be mapped**. Satisfaction from learning, obtaining a membership for a professional association, completing a given certification, sharing knowledge and meeting new people, and bringing value to their communities are example of these multiple motivations. They should be mapped for the organisation to review how they are presently being addressed, however subjective they may be. By increas-

ing the input from users, a larger base on how to approach these abstract motivations in practice can be created.

Table 5.1: Summary of Findings &amp; Areas of Concern

Categories	Areas of Inquiry	A1	A2	A3	A4	A5
Organisation	Learning Pillars		X			
	Recognition and Visibility of Expertise			X		
	Interaction with External Actors	X				
Environment	Transparency of Change Learning	X				
	Leadership Capability		X			
Technology	Change in Implementation				X	
	Continuous Improvement Capability	X				
Task	Concerns on New Forms of Work					X
Individual	Professional Identity			X		

## 5.2 Opportunities & Obstacles for Responsible Innovation

### 5.2.1 Answering the SRQ5

The fifth sub-research question as specified in **Section 1.2** is:

**What opportunities does Responsible Innovation offer for supporting employee well-being in the associated company?**

**Section 5.1** has discussed findings and provided a superficial connection between the 9 Areas of Inquiry and the 4 RI dimensions. By reviewing the indicated Areas of Inquiry, the company is having a discussion on employee well-being. The opportunity, or added value of RI is brought by its critical angle. The RI dimensions can be taken as criteria to study and reflect on the indicated areas. They suggest a first step, to what extent is the organisation doing A or B action in this area with regard to the specified dimension?.

**Table 5.2** presents the possible opportunities for the company. The idea is that an opportunity is shown through a connection between area and dimension. The connection is made by asking a reflection question pertaining to the area and the dimension. For example, in the case of Learning Pillars, the connection to Inclusive is made by asking, to what extent is GOPS mapping the preferences of users to design new trainings? By asking such question one takes an observatory and critical stance towards the current practice and seeks to obtain further knowledge for its improvement—hence an opportunity.

In principle, one could make an effort to link the areas to all dimensions. With some creativity this is possible. However, due to the limited scope of the project, only two are indicated. Number 1 and 2 in the table show these connections. A number 1 indicates a prominent connection, and 2 a secondary. Prominence can be understood as a straightforward, notable connection between concepts. The complete list of questions suggesting the connections is included in the **Appendix D.1**.

Table 5.2: Opportunities for Responsible Innovation in the Study of the Areas of Inquiry

Categories	Areas of Inquiry	Ant.	Resp.	Incl.	Ref.
<b>Organisation</b>	Learning Pillars	2		1	
	Recognition and Visibility of Expertise			2	1
	Interaction with External Actors	2		1	
<b>Environment</b>	Transparency of Change Learning		1		2
	Leadership Capability		1	2	
<b>Technology</b>	Change in Implementation	2		1	
	Continuous Improvement Capability		2		1
<b>Task</b>	Concerns on New Forms of Work	1		2	
<b>Individual</b>	Professional Identity			1	2

### 5.2.2 Answering the SRQ6

The sixth sub-research question as specified in **Section 1.2** is:

**What obstacles does Responsible Innovation face in supporting employee well-being in the associated company?**

In **Section 3.6** the literature indicated four obstacles RI faces in practice: managing the diversity of views, values, and beliefs between parties (DS); the asymmetry of information and power (IA); the inherent uncertainty or wickedness of developing future projects (IU); and the resistance of people to change and modify their practice (RP). **Table 5.3** connects the 9 Areas of Inquiry with a plausible obstacle they may face.

Similar to RI Opportunities, the connection between Area and Obstacle is made by asking a reflection question. For example, addressing Leadership Capability faces Information Asymmetry as managers should balance protectionism and promotion of early projects. A germane question is, how should leaders be trained to balance project protection and knowledge exchange?

In the table only one obstacle is indicated. In practice, the areas could face multiple obstacles. Due to the scope of the project, only the most urgent link as considered by the author is presented. The link simply indicates that a further study is needed to ascertain the impact and likelihood of these obstacles. The complete list of questions suggesting the connections is included in **Appendix D.1**.

Table 5.3: Obstacles for Responsible Innovation in the Study of the Areas of Inquiry

Categories	Areas of Inquiry	DS	IA	IU	RP
<b>Organisation</b>	Learning Pillars	X			
	Recognition and Visibility of Expertise	X			
	Interaction with External Actors		X		
<b>Environment</b>	Transparency of Change Learning		X		
	Leadership Capability		X		
<b>Technology</b>	Change in Implementation				X
	Continuous Improvement Capability				X
<b>Task</b>	Concerns on New Forms of Work			X	
<b>Individual</b>	Professional Identity		X		

## Chapter 6

# Conclusion & Recommendations

This final chapter has 4 sections. **Section 6.1** recaps the sub-research questions that give answer to the central RQ; **6.2** indicates implications for practice and for other organisations; **6.3** suggests future work based on limitations of the study; and finally, **6.4** contains a personal reflection on research design and execution.

<b>Section 6.1</b> Conclusion RQ	<b>Section 6.2</b> Implications	<b>Section 6.3</b> Future Work	<b>Section 6.4</b> Reflection
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### 6.1 Research Questions

#### 6.1.1 The Road towards the Research Question

The question that guides the execution of this project is, *how can Responsible Innovation benefit the employee well-being in the Transformation 4.0 of the associated company?* To arrive to the answer six sub-research questions guided the process. If you have already reviewed these answers in previous chapters, please continue to the next sub-section (**6.1.2**). Otherwise, let us recap what their answers were.

The **SRQ1** asks *how can employee well-being be explored in a company?* The concept of well-being can be explored through the **Working System** as described in **Section 3.3**. This characterisation has **5 categories: Organisation, Environment, Technology, Task, and Individual**. A complete list of factors for these categories is included in **Appendix B.2**.

In the case of the associated company, **16 factors were selected as relevant for the study of well-being**; these are shown in **Table 3.2**. Note these factors are not conclusive in indicating how well-being is impacted. They are subjects of study on their own. Addressing them should trigger a reflection on how their existence is managed inside the company. This awareness is likely to mobilise efforts for the support of these factors.

The **SRQ2** inquires on *what social concerns of the Transformation 4.0 may impact the employee well-being in a company?* The literature review in **Section 3.5** identifies **5 Areas of Concern**. These areas suggest a need to review organisational structures, training and recognition programs, technology adoption processes, and the creation of a flexible working environment. These may not indicate novel problems affecting organisations, but they emphasise **the effort to review the current practice in their regard**. These areas

can be connected to well-being factors of the Working System. Not addressing these concerns may bring about unfavourable working conditions for employees. Connections between factors and areas are shown in **Table 3.4**.

The theoretical framework of the thesis is completed with **SRQ3**, which indicates *what does a Responsible Innovation approach suggest with respect to the Transformation 4.0?* The approach is defined in the context of the transformation as **the lens through which the design and implementation of the working practice can be observed, assessed, and improved**. **Section 3.7** specifies its 4 dimensions: **anticipatory, reflexive, inclusive, and responsive**.

The **SRQ4** opens the investigation into the corporate case by asking *how does the associated company manage the impact of the Transformation 4.0 on employee well-being?* **Section 4.5 connects the 5 Areas of Concern to internal organisational efforts**. The links are made between one area and one effort, and they should not be taken as representative for the organisation. They simply provide **an initial context for the study**. Their information was used for the preparation and execution of the interviews.

They too were used for the analysis of results which suggests the company to review current efforts on the **9 Areas of Inquiry**. These are indicated in **Table 4.3** and include: a review on current learning pillars; visibility of subjects experts across units; opportunity for rank and file to increase their outward-looking capability; capturing and sharing of lessons across groups; understanding and action on various forms of leadership; opportunity for the central change group to bring value to project groups; the additional opportunity of embedding continuous improvement methodologies in the daily work of project groups; anticipation on more abstract, future requirements for new tools; and the evolving and diverse motivations by employees.

Furthermore, the **SRQ5** looks into *what opportunities does Responsible Innovation offer for supporting employee well-being in the associated company?* By reviewing the above-mentioned 9 Areas of Inquiry, the company is having a discussion on the subject of employee well-being. The opportunity, or added value of RI, is the critical angle it brings to study and reflect on the indicated areas. They suggest a first step, to what extent is the organisation doing A or B action in this area with regard to the specified dimension? These areas are connected to the different dimensions in **Table 5.2**.

Finally, the opportunities of the RI lens suggest an **ideal** to which the organisation can direct efforts. The practical challenge of working on these efforts is highlighted by the **SRQ6**, *what obstacles does Responsible Innovation face in supporting employee well-being in the associated company?* **4 practical obstacles** in addressing the Areas of Inquiry through the RI lens are indicated: **diversity of views, information asymmetry, inherent uncertainty, and people's resistance**. These obstacles are exemplified through the connections made in **Table 5.3**.

### 6.1.2 Answer to the Research Question

Reliance on bossy supervisors, poor relationship with team members, outdated trainings, bleak career perspectives, monotonous and intensive work illustrate working conditions that can negatively affect the psychological state of employees. These erode the employees' engagement upon their work, and if this occurs over a prolonged period of time, additional undesired health consequences may ensue. Such poor organisational attention impacts the well-being of employees. This is not a new insight and managers commonly strive to enable opposite conditions: attentive and agile leaders, a collegial working atmosphere, impactful education programs, and a rewarding daily job. **In the case of the organisation under study, these are concrete goals for which current efforts are in place.**

However, with the prospect of introducing new technologies to the workplace and with these redefining employees roles, the need to review these efforts arises. Looking closer at the existing structures and employees attitudes is likely to help in the Transformation 4.0 process—*but what else?* Before jumping into the future **a review of the present state is needed.**

Here, **the responsible innovation approach brings its value to the company.** The RI lens is suggested as an extension of the current manager's tool-set. Their dimensions can be used as criteria for the evaluation of current practice, and the design and implementation of the new one. The lens triggers a **reflection**, which in the context of this study places employee well-being in a **central position.**

**Appendix D.1** presents the reflection questions that are triggered thanks to the RI lens and which are useful for managers in the company. This reflection can be used by other managers in other organisations.

Without the lens, the organisation still has under its radar the subjects brought up by the 9 Areas of Inquiry. However, the RI lens is **specific** in the 4 dimension, which can be used as criteria. Hence, one could ask with Anticipation and Inclusion “what foresight activities help in anticipating the misuses of a new tool?, and when in the design process do employees provide input on preferred ways of working?” These questions **reinforce** the design process and assist managers in the **evaluation** of current actions.

Note this initial reflection is a basis for subsequent action. In the case of Responsiveness, if current structures do not allow leaders to be agile in acting upon misused of new tool (as reported by internal cases), then, resources are mobilised for improving the practice. **The learning from the initial reflection demonstrates value which warrants similar reflections in other groups.** The enhanced reflection, and potential demonstration of benefits, can upgrade the lens to **a more integral activity** (e.g., an explicit component of the company's project methodology).

## 6.2 Implications

### 6.2.1 For Practice

This section presents a more concrete discussion on the implications of the RI reflection for the company. The 9 Areas do not bring an entirely new and different view. Quality of leadership, update on new skills and training, employee recognition, and sharing with external partners are already important subjects for the company. In this study a **trailing** of the transformation was originally proposed. This suggests a **first need to review**. Out of the 9 areas, as discussed with people in the company, 3 topics present a higher urgency. These are: **(1) the transparency of change learning, (2) the change aspects in implementation, and (3) the continuous improvement capability**.

As for the **transparency of change learning**, the organisation should explore **how people capture, adapt, and consciously implement valuable learnings from sharing moments to their sub-practice**. Sharing sessions are key components of the daily work in the organisation. Though, it difficult to identify how knowledge across groups are captured and adapted.

It is **not the intention to fix with a prescribed methodology how the capturing and sharing should be done**, but it should be acknowledged that human capacity is limited in storing and shaping knowledge for its utilisation. **It is not only about the quantity of sharing, measured by the number of meetings and connections, but also about the impact of the lessons learnt being adapted to the daily work of a unit**.

In the same vein, to what extent is the **sharing occurring outwards**, how employees interventions transfer value to other units? What is the quality of delivery; the sharing of a lesson-learnt in a language that resonates with others and elicits back contributions. **How line managers are actually managing the sharing of information and whether they are using indicators of daily practice (KPIs) to measure the impact?**. Employees could also provide input on their experiences, **what has determined for them a fruitful exchange session, or what has helped them in effectively suggesting actions to other colleagues?**

As for the **change aspects in implementation**, the organisation should review **what is the minimum common understanding on addressing and acting on well-being factors during design and implementation of new digital projects**. The current methodology for planning and implementing projects gives project managers considerable flexibility in guaranteeing that change management aspects are included in the process. Again, it is **not the intention to stifle the manager's ability to plan and design, but a common rich base on exploratory activities should be shared by all managers**.

This implication could simply be a fresh reminder to leaders on the importance of early involvement and two-way communication for mapping user demands for new tools. Here, the four dimensions of the Responsible Innovation can help to evaluate current actions.

An important remark in here is that the organisation should revisit **how change management knowledge is being shared from the central unit to other smaller units**. The organisation has a considerable share of experience in change management. However, the **change knowledge appears to be documented in terms of the large unit of analysis following from organisational change due to restructuring**. This suggests a review on how the central function is being effective in building the capability of



units. The difficulty by project managers to embed change aspects in their implementations may follow from the complication change packages actually represent for them. They do not rely on **light packages of change learnings, as a tool-set**, which contain central unit knowledge but in the language of the unit and its context.

As for the **Continuous Improvement (CI) capability**, the organisation should inquire on **how are learnings from this function impacting the work of project units during early design and implementation stages**. The **strong focus on technical aspects during early design stages may be reinforced by the employee perception on the ability of CI to address social aspects later in the process**. Indeed, these can be addressed but to what extent and to what cost. Besides cost of resources, it comes at the expense of employee's trust in the tool, process and working group.

Finally, the CI function may be investing in project units to take action on their own hands, but **to what extent are these units using CI in their daily practice?** The CI may also be perceived as a central unit with its own language. Here the focus is similar to that of the change group— translating lessons-learnt and cases to the language and context of project groups.

**How to use the RI lens?** The value of the lens does not follow from just asking, but reflecting and taking action. This does not suggest a contemplation and philosophical exercise on the company. Instead, managers should be aware of the nature of the question that can be triggered by the lens.

**Fig. 6.1** [as inspired by the seminal work of Argyris & Schön [82]] gives an example for User Involvement in Requirement Specification of New Tool. Taking the RI dimensions as criteria implies a first evaluation of current efforts (Single Loop). Next, RI suggests a reflection on the dimensions being actually embedded in those current efforts (Double Loop). Finally, due to recognised value of the dimensions within the efforts, the further institutionalisation is aspired. Thus, a reflection on the value of having reflected is made (Triple Loop); this is the basis for arguing why these resources have been invested (i.e., involving people) and allows to transfer RI to other cases.

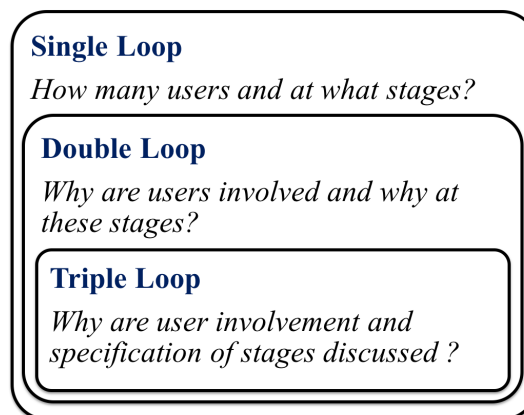


Figure 6.1: Responsible Innovation: Critical Reflection Exercise Example

### 6.2.2 For Organisations

Other organisations can benefit in equal measure from the output of the theoretical framework. Firstly, the characterisation of the Working System is equally applicable to their context and other interested managers should select the factors they find more convenient for their study. For this purpose, they can rely on the more extensive list of factors in **Appendix B.2**. Secondly, the 5 Areas of Concern are descriptive of the industrial landscape, hence equally relevant. Thirdly, the reflection questions in **Appendix D.1** can be used in other cases.

As for the Areas of Inquiry particular, all 9 topics are of relevance to other organisations. These, of course, may not be complications of their practice, but managers could in the same way inquire on how these topics are addressed. The RI lens can guide their reflection.

Managers in design and technology teams who would like to review the human-centredness of their methodology are also referred to the scholar work of [71, 83]. In here, the design of robots is guided by the RI lens. Execution and review on the process can be duplicated in other organisations, as it may well fit their rapid deployment of new technologies for their workplaces.

Finally, from the more concrete implications, two findings also apply to other organisations—**lightness and decentralisation**. **Lightness refers in a more general sense to the ability to encode and share findings and lessons-learnt with other units outside that from which they originated**. This may be hinder by a number of reasons: confidentiality, existence of organisational silos, or simply due to the inability to translate these information to a language used in other contexts.

**Decentralisation refers to enabling adjacent units to the central to build internal capability in a particular area of expertise**. This connects back to the lightness as part of the decentralisation is made possible by the ability to transfer knowledge in language other than that used by the central function. This finding equally applies to other organisations.

### 6.3 Future Work

This study has six limitations concerning theory, methods, and findings. From these limitations, future work is proposed:

#### Limitations on Theory

Firstly, **the coverage of the Working System factors should be extended.** The coverage in this study is representative as defined in **Appendix B.2**. However, the classification and selection of factors is not exhaustive. The review was based on literature from different disciplines and this brought considerable difficulty in avoiding overlap and repetition between factors. Even though selected factors were verified for their relevance by the supervisory team in the organisation, the contact time for verification was limited.

Future work could benefit from increasing the number of people in the verification process and the contact time with them. Besides the diversity of literature, the challenge in the selection of factors follows from their degree of abstraction. Factors are not only concretely measured with a yes or no, but also in terms of their quality. The additional verification time would allow for additional feedback on how good these factors are interpreted inside the organisation and how practical is their measurability.

Secondly, **the coverage of the 5 Areas of Concern should be extended.** The urgency inside the organisation has been motivated by 5 general areas. These are not specific in stating what this or that problem may be. Future work should focus on reviewing what specific problems could emerge from these reviews. For example, for the case of Diverse and Flexible Working Environment, a specific project could look at an office or factory with employees of one age-range. Similarly, the work would do better in specifying the need to review training forms for virtual teams, instead of simply suggesting that the broad area of Skills and Training should be reviewed. Through specification, problems inside the organisation can be more likely identified.

In addition, the coverage of areas is not exhaustive in that the transformation urges a review on current capabilities of Standardisation and the organisation's Intellectual Property [62]. In the scope of this study, these topics were left out as they border more technical implications.

#### Limitations on Methods

**The data collection process should be more thoroughly documented.** The interviews in this project were not recorded and notes taken were not included as literal transcriptions in this report. Despite following interview protocols in **Appendix C.2**, interviews have been conducted rather informally inside the organisation. This clearly threatens the credibility of the work and its transferability.

In my defence, interviews took the form of conversations around improvement areas, rather than interrogations, which allowed for a more transparent atmosphere during the interviews. The findings from the interviews as presented in **Section 5.1** are to the best of my capability the paraphrasing of the interviewees' answers. These were validated with participants as part of the triangulation strategy to avoid any misinterpretation and false reporting.

Additionally, the documentation and analysis could have benefited from a more rigorous coding strategy (cf. [80]). The coding in this work is simple and follows from

the literature review (i.e., Working System categories, 5 Areas of Concern) and from post-interview discussion with interviewees (i.e., 4 Clusters of Inquiry after Interview Round 1, and 9 Areas of Inquiry after Round 2). Future work should document it in more detail and verify these categories with other parties. Certain categories in this work were not double checked with other parties.

### Limitations on Results

**The data sources should be increased to increase reliability of findings.** The formulation of the 9 Areas of Inquiry follows from a limited sample of interviews. The views from these people may be biased and should not be taken as representative of the whole organisation. These answers may be half-truth as a full disclosure on the organisation's problems may not be necessarily desired by the interviewees. In spite a friendly interview atmosphere and a clear non-publication clause in the interview protocol, they may feel that any leak of information from these interviews could compromise their jobs. Increasing the number of interviewees would reinforce findings and bring additional angles that these first interviews did not capture. Obviously, the size of the interviews should be kept manageable.

My particular preference would be to increase the sample by 3 (hence,  $n=12$ ) and bring the final results to them. The purpose of this final round would be to confirm the 9 areas, sharpen the three final practical implications **Section 6.2**, and the RI questions that have been asked in **Appendix D.1**. In my view, this would still fall in the scope and time-budget of the Management of Technology thesis.

Finally, **the activities that capture the RI dimensions should be specified inside the organisational context. The RI lens brings a critical angle to the managers practice, but its use may be abstract if their techniques and approaches are not indicated** (cf. [30, p.1573]). Examples of inclusive activities could be: focus groups, online sharing platform, and ideation workshops. This specification should be done for all dimensions so that internal capabilities are evaluated. If the effectiveness of current actions is not sufficient, managers may take actions for improving them or for designing new activities accordingly.

## 6.4 Reflection

### 6.4.1 On Research Objectives

This study was designed based on five objectives as indicated in **Section 1.2**. The objectives have been achieved to different degrees; **A three-star scale is proposed**. These represent to what extent the objective has been accomplished. 3\*\*\* stars suggest that the objective has been satisfactorily completed; and 1\* star that it has been partly completed requiring considerable future work.

1. **Explore the impact of a digitised workplace on the workforce well-being: This objective was completed with 3\*\*\*** Indeed, the exploration of the working system should be more extensive, and the work would have profited from specifying a digital workplace inside the organisation. However, **the work provides a good foundation for exploring the impact of the workplace on the workforce well-being**. Upon this work, the concrete elements of a new digitisation project (e.g., autonomous and self-learning computers) and new form of work (e.g., digital presence and virtual team collaboration) can be added.
2. **Identify actions of the associated company to mitigate the negative impact of the Transformation 4.0 upon employee well-being: This objective was completed with 1\*** In **Section 4.5** the current actions are linked to the external concerns of the transformation. It is argued that by addressing these concerns, the well-being factors are also addressed. This last link is not clear and more extensive work would have connected the sixteen indicated factors with specific efforts. Moreover, efforts are not spelled out in great detail and these efforts contain other activities that have not been reported. The extension of such study would have fallen out of the scope of project and would have required a different degree of access to information. **The stay at the company was too short to manage a larger study on current efforts and in that case, the interview questions should have been defined in a different way.**
3. **Recommend actions based on an RI approach to address the possible gaps and support well-being: This objective was completed with 2\*\*** The 9 Areas of Inquiry are not new to the organisation. However, their connection to the RI questions as presented in the **Appendix D.1** bring a **fresh angle of study in the practice**. The questions are rather specific and can trigger other reflection questions. Additional work could ask these questions in a specific department and for a specific project. Examples of techniques and approaches for taking action on the areas of inquiry should given.
4. **Indicate obstacles and opportunities for RI to become institutionalised in the current practice This objective was completed with 2\*\*** The questions around opportunities and obstacles as included in **Appendix D.1** are insightful. The final interviews with people from the organisation provided validated their usability. However, for an institutionalisation, more than a reflection is needed. In this case, the current structure should be described, similar actions identified, improvements designed and proposed. This action falls out of the scope of the thesis.
5. **Contribute to the RI literature for the approach to become a standard practice in industry This objective was completed with 1\*** This is a very ambitious goal as no theory has been generated from this study. The value that this study brings to larger theory is that it is feasible to structure an application case. Moreover, practitioners have recognised the RI value as an extension of their decision-making tool-set.

**The value brought by the criteria of the RI lens is endorsed, as they connect well with the experience of change managers in the company.**

#### 6.4.2 On Research Approach and Methods

As for Trailing Research, its execution went very smoothly. **It proved to be a valid and very useful action framework for a research-based project in an organisation. Its principles (i.e., researcher is not a change agent and has no responsibility for changing the practice) fits well with the level of experience and time-budget of the project.** A more traditional action-research approach would have required that the researcher designed and tested, at least once, a possible solution for the practice. In such case, a different planning together with a less ambitious and more specific problem definition would have been required.

As for the Interviews, the learning was satisfactory. For the first meetings, I believed I used academic language that required effort from them. With their feedback, I was able to improve the formulation of my questions. This improvement aimed to shorten the message and avoid any bias. With influence from the literature review and the first contacts, I may have been already biased on what efforts should be made in the company. I needed to be cautious not to convey this concern to the interviewee.

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# Appendix A

## Ch.2 Research Design & Methodology

### A.1 Quality Criteria

In addition to the quality criteria presented in **Section 2.5**, Eden and Huxham [43, p.83] recommend the following 12 considerations. These are directed towards work based on an action research approach. After each consideration a commentary is included to indicate how it has been addressed in the study.

1. Research must have implications beyond those required for action or generation of knowledge;
  - Yes, findings of this study can be used to inform other organisational contexts.
2. Research demands an explicit concern with theory;
  - Yes, the study is based on established concepts and theories.
3. If the generality drawn out of research is expressed through design of models or methods then this alone is not enough;
  - Yes, recommendations for the design of a practice in other organisations are based on theory.
4. Research generates emergent theory;
  - No, the objective of the research is limited in that emergent theory is not expected to be developed.
5. Theory building will be incremental, moving from the particular to the general;
  - Yes, even though no explicit theory is developed out of the study, findings are synthesised from the particular and a conclusion is drawn towards the general context.
6. Research does not present a false dichotomy between prescription and description;
  - No, even though findings are presented in form and style appropriate to the company, it is not the intention that the findings trigger change as to what the company should do.
7. A high degree of method and orderliness is required;
  - Yes, it is striven for and the strategy is explained in the entirety of **Chapter 2**.
8. The process of exploration, rather than collection, must be replicable or demonstrable through argument or analysis;
  - Yes, it is striven for and the strategy is explained in the entirety of **Chapter 2**.
9. Adhering to the eight contentions above is necessary but not sufficient condition;

- Yes, note the two contentions that are not fulfilled follow from the master thesis nature of the project in that it is limited in time and depth of investigation.
10. Having the knowledge about, and skills to apply method and analysis procedures for collecting and exploring rich data is essential;
- Yes, knowledge and skills are present though not honed. It is the intention that this study serves as an exercise for the student-researcher to improve his skills.
11. Opportunities for triangulation should be exploited fully and reported;
- Yes, **Section 4.2** explains the triangulation strategy for the corporate case.
12. The history and context for the intervention must be taken as critical to the interpretation of validity and replicability of the results;
- Yes, **Section 1.4** presents the urgency and relevance of this study.

# Appendix B

## Ch.3 Literature Review

### B.1 Literature Review Methodology

This appendix is an extension of **Section 3.1** and describes in detail the execution of the literature review. The guiding framework is by Vom Brocke et al. [46] and it consists of five steps as presented in **Fig. 3.1**.

#### B.1.1 Step I: Defining the Scope

The first step is to specify the scope of the literature review. The specification is best achieved by visiting the taxonomy of reviews by Cooper [84]. The taxonomy articulates the scope of the review through six categories. These and their various characteristics are presented in **Table B.1** and should be straightforward to grasp for the reader. For instance, the first category, Focus, asks the researcher a similar question to “what is the material to be covered that is of central interest to the researcher?”, to which the answer may be “the Research Methods used or the Research Outcomes obtained.” It is worth noting that some categories allow for combination of characteristics (e.g., a review with focus on theories and applications) and some do not as they are mutually exclusive per definition (e.g., a perspective cannot simultaneously be neutral and espousal of a position).

Table B.1: Taxonomy of Literature Review: Categories and Characteristics

Category	Characteristic	Clarification
Focus	Research Outcomes	<i>Material covered focuses on...</i>
	Research Methods	
	Theories	
	Applications	
Goal	Integration	<i>Review’s goal is...</i>
	Criticism	
	Central Issues	
Organisation	Historical	<i>Material is organised in this way...</i>
	Conceptual	
	Methodological	
Audience	Specialised Scholars	<i>Material is directed to an audience of...</i>
	General Scholars	
	Practitioners	
	General Public	
Perspective	Neutral Representation	<i>Perspective on the subject is conveyed as a...</i>
	Espousal of Position	
Coverage	Exhaustive	<i>Literature is covered to this extent...</i>
	Exhaustive & Selective	
	Representative	
	Central & Pivotal	

Well-being (WB), Industry 4.0 (I40), and Responsible Innovation (RI) are the three central

topics of the literature review and **Table 3.1** presents the characteristics of their review. These characteristics are meant to aid the search process, limit its scope, and allow to some degree its replicability, however, they should not be taken as absolute.

### B.1.2 Step II: Conceptualising the Topics

The second step defines the topic. For this purpose, a keyword exploration is performed. The exploration identifies concepts and additional terms that are used by the scientific and professional community to refer to the three central topics. A search on *Scopus* on the 30<sup>th</sup> March 2017 was performed and it resulted in an overview of keywords as shown in **Table B.2**. An additional search was performed in *Web of Science*, but it did not provide additional keywords. The heading term on the table was used as the basic search query and results were limited to peer-reviewed articles and conference proceedings.

The keyword exploration does not unnecessarily broaden the search. Rather, it provides a larger keyword-pool from which subsequent searches can benefit. If the initial combination of keywords does not provide extensive results, alternatives can be tested. For example, this was the case for the search on the fourth industrial revolution. The term 'Industry 4.0' is primarily bound to the European context, therefore, the alternative 'Human Robot Collaboration' is used. This term expanded and rendered the search more fruitful as the literature found matched with both the technical and social dimension of the industrial transformation.

Table B.2: Keyword Identification around Central Topics

Industry 4.0	N=645	Human Robot Collaboration	N=99	Well-being	N=106032	Responsible Innovation	N=128
Embedded Systems	136	Human Machine Collaboration	66	Quality of Life	15980	Human	19
Cyber Physical Systems	134	Human Computer Interaction	20	Psychological Aspect	10393	Ethics	16
Internet of Things	98	Man Machine Systems	15	Health Status	7388	Nanotechnology	14
Automation	72	Artificial Intelligence	14	Mental Status	7263	Research	12
Big Data	56	Decision Making	11	Mental Stress	3147	Social Responsibility	9
Industrial Revolutions	51	Robotics	9	Stress	3074	Sustainability	9
Industrial Research	38	Human Machine Interaction	6	Adaptive Behaviour	3032	Sustainable Development	9
Factory Automation	34	Computer Supported Cooperative Work	5	Risk Factor	3019	Emerging Technologies	7
Production System	32	Personality	5	Health Promotion	2867	Governance	6
Smart Factory	29	Social Aspects	4	Ageing	2869	Social Behaviour	6
Smart Manufacturing	28	E-learning	4	Personal Satisfaction	2738	Public Engagement	5
Virtual Reality	21	Interactive Computer Systems	4	Coping Behaviour	2358	Research Ethics	5
Product Design	20	Cognitive Engineering	3	Risk Assessment	2200	Responsibility	5
Process Control	19	Emotion	3	Organisation & Management	2166	Competitiveness	3
Cloud Computing	18	Human Skills	3	Daily Living	2100	Corporate Social Responsibility	3
Design	18	Knowledge Management	3	Psychometrics	2055	Foresight	3
Robots (Robotics)	18 (14)	Philosophical Aspects	2	Perception	2008	Innovation Process	3
Industrial Production	17	Human Operator	2	Subjective Well-being	1948	Midstream Modulation	3
Augmented Reality	16	Social Behaviour	2	Fatigue	1823	Public Policy	3
Human Computer Interaction	15	Situational Awareness	2	Employment	1732	Research & Development	3
Industrie 4.0	14	Social Intelligence	2	Social Interaction	1732	Socio-technical Integration	3
E-learning	13	-	-	Distress Syndrome	1638	Stakeholder Engagement	3
Behavioural Research	9	-	-	Procedures	1461	Technical Development	3
Digital Factories	9	-	-	-	-	Value Sensitive Design	3
Human Machine Interaction	9	-	-	-	-	Anticipation	3
Knowledge Management	9	-	-	-	-	Human Experiment	2
Automation Systems	8	-	-	-	-	Industrial Management	2
Digitalisation	8	-	-	-	-	Implementation Process	2
Human Resource Management	8	-	-	-	-	Interdisciplinary Approach	2
Industrial Management	8	-	-	-	-	Laboratories	2
Learning Factory	8	-	-	-	-	Life Cycle Assessment	2
Human Engineering	7	-	-	-	-	Quality of Life	2



### B.1.3 Step III: Searching for the Literature

This third step provides a preliminary selection of the literature. The strategy is based on four steps: exploration of database, exploration of journal, keyword identification, and backward search.

- **Database** The idea of this step is to determine a suitable database for the search process. For literature on engineering and business two widely known and robust search systems are *Scopus* and *Web of Science*. These two were selected for this study, given their reputation, extension, and availability. These databases can be accessed thanks to the affiliation of the researcher with the *Technische Universiteit Delft*. Due to limited time-budget in the project, no additional search was performed in other databases. Nevertheless, *ABI/INFORM Complete* and *JSTOR* were selected as back-up when publications (e.g., from backward search) were identified and these were not retrieved by the main databases.
- **Journals** *Scopus (S)* and *Web of Science (WoS)* are very useful in this second step of identifying the most relevant journals in where peer-reviewed papers are published. Both databases allow for the analysis of journals based on various metrics. For example, three metrics used in *Scopus* are SJR (SCImago Journal Rank), CiteScore, SNIP (Source Normalized Impact per Paper) and they correlate with the quality of the journal. It is safe to assume that the higher the quality of the journal, the higher the quality of a research paper. More information on the metrics and their use can be found in the *Help* section of these databases. Publications were not strictly selected from the leading journals, but the knowledge obtained from this exercise served as a quality check for the final selection. **Table B.3** gives as a form of illustration an overview of the most relevant journals around the subject of Responsible Innovation. The search was done on the 30<sup>th</sup> March 2017, it was limited to peer-reviewed articles, and its query was 'Responsible Innovation' OR 'Responsible Research and Innovation'.
- **Keyword Search** The keyword exploration of step II is meant to be an exploration of keywords for a better conceptualisation of the central topic (e.g., with I40 I am particularly looking for the HCI aspect); whereas the exploration of step III specifies what exact combination of keywords was used. **Table B.4** presents the initial queries used in the search. It includes the most relevant keywords for this study and results are narrowed down only to include peer-reviewed articles from scientific journals and conference proceedings. The former are of higher quality over the latter, so they have been prioritised [85]. An interesting observation from the results is the fact that the combination of keywords presents limited work on updating, integrating and expanding the topics of the fourth industrial transformation with employee well-being (e.g., # 8-12), and with responsible innovation (e.g., # 13-16).
- **Backward Search** With a backward search preceding publications that were cited in articles found through the main search queries are identified. An example was the retrieved work by Cooper [84], as the explanations given in Vom Brocke et al. [46] were limited. Various backward searches were executed as they allowed for the identification of central literature on the topics (e.g., [3] for WB, [62] for I40, and [29] for RI).

Table B.3: Comparison of Relevant Journals on Responsible Innovation

Journal Title	Publications S (WoS)	5-year Impact Factor	JCR Category	CiteScore	SJR	SNIP
Science & Engineering Ethics	17 (17)	1.323	Ranked 4 out of 60 in History & Philosophy of Science; 12 out 51 in Ethics	1.11	0.372	0.819
Nanoethics	12 (11)	0.591	20 out of 60 in History & Philosophy of Science;	1.04	0.333	0.733
Life Sciences Society & Policy	10 (-)	-	-	-	-	-
Science & Public Policy	6 (7)	1.515	25 out of 55 in Planning & Development	1.78	0.623	1.099
Technology in Society	5 (2)	0.185	-	1.27	0.321	0.762
Technological Forecasting & Social Change	5 (5)	3.005	4 out of 55 in Planning & Development	3.28	1.348	1.752
JCOM Journal of Science Communication	3 (3)	-	-	0.28	0.159	0.263
Journal of Agricultural Environmental Ethics	3 (2)	1.266	6 out of 60 in History & Philosophy of Science;12 out 51 in Ethics	1.07	0.508	0.692
Research Policy	3 (3)	5.118	2 out of 55 in Planning & Development	5.61	3.536	3.126
Risk Analysis	2 (2)	2.535	6 out of 40 in Public, Environmental & Occupational Health	2.51	1.326	1.437

#### B.1.4 Step IV: Analysing and Synthesising the Literature

Once with knowledge of the leading journals, the trusted databases, and the relevant keywords the search has been performed. The search is not limited to a fixed period of time and results are ordered based on the number of citations. From the results, titles are scanned. Many of the publications are immediately discarded as they are too specific. Given the characteristics of the review, titles that suggest a broader approach to the topics are selected and their abstracts are screened. Publications with abstracts that indicate an integral approach to the central topic and match with the keyword exploration are selected for further review.

In the case of WB, the term results in a large number of publications. However, the exclusion of results is rather straightforward as the majority applies to well-being of youth, students, the elderly and refugees, among others. Only titles that indicate work environment, organisation, or workers were selected and their abstracts scanned. In the case of RI, the term does not result in a large number of publications, but there is still some filtering to do as many publications have a central discussion around a specific ethical concern, say, new genetic and medical interventions, energy and infrastructure projects, among others. Finally, in the case of I40, the search expands to include work on human computer interaction. Intersection between subjects is achieved by combining queries. The reference manager *Mendeley* is used and this avoids the selection of duplicates. The selected literature for this study can be found in the **Reference** list.

#### B.1.5 Step V: Setting the Research Agenda

After having reviewed the papers, additional gaps in the literature may be identified. This allows for the creation of a subsequent research agenda. In the case of this study, there is no immediate need to extend the research. Recommendations for future work, especially for extending the literature search around the central topics, are provided in the **Section 6.4**.

Table B.4: Search Queries around Central Topics: Singular and Combinations

#	Keyword	Results	Query
1	Industry 4.0 (I40)	645	TITLE-ABS-KEY ( "Industry 4.0" ) AND DOCTYPE ( ar OR cp )
2	Human Machine Interaction (HMI)	2822	TITLE-ABS-KEY ( "Human Machine Interaction" ) AND DOCTYPE ( ar OR cp )
3	Human Machine Collaboration (HMC)	99	TITLE-ABS-KEY ( "Human Machine Collaboration" ) AND DOCTYPE ( ar OR cp )
4	Automation (A)	230648	TITLE-ABS-KEY ( "Automation" ) AND DOCTYPE ( ar OR cp )
5	Digital / Smart Factory (DSM)	644	TITLE-ABS-KEY ( "Smart Factory" OR "Digital Factory" ) AND DOCTYPE ( ar OR cp )
6	Responsible Innovation (RI)	128	TITLE-ABS-KEY ( "Responsible Innovation" ) AND DOCTYPE ( ar OR cp )
7	Wellbeing (WB)	106032	TITLE-ABS-KEY ( "Wellbeing" ) AND DOCTYPE ( ar OR cp )
8	I40 AND WB	2	( TITLE-ABS-KEY ( "Industry 4.0" ) AND DOCTYPE ( ar OR cp ) ) AND ( TITLE-ABS-KEY ( "Wellbeing" OR "Well-being" OR "Well being" ) AND DOCTYPE ( ar OR cp ) )
9	A AND WB	241	( TITLE-ABS-KEY ( "Automation" ) AND DOCTYPE ( ar OR cp ) ) AND ( TITLE-ABS-KEY ( "Wellbeing" OR "Well-being" OR "Well being" ) AND DOCTYPE ( ar OR cp ) )
10	HMI OR HMC AND WB	10	( TITLE-ABS-KEY ( "Human Machine Interaction" ) AND DOCTYPE ( ar OR cp ) ) OR (TITLE-ABS-KEY ( "Human Machine Collaboration" AND DOCTYPE ( ar OR cp ) AND ( TITLE-ABS-KEY ( "Wellbeing" OR "Well-being" OR "Well being" ) AND DOCTYPE ( ar OR cp ) )
11	DSM AND WB	0	( TITLE-ABS-KEY ( "Smart Factory" OR "Digital Factory" ) AND DOCTYPE ( ar OR cp ) ) AND ( TITLE-ABS-KEY ( "Wellbeing" OR "Well-being" OR "Well being" ) AND DOCTYPE ( ar OR cp ) )
12	RI AND WB	2	( TITLE-ABS-KEY ( "Responsible Innovation" ) AND DOCTYPE ( ar OR cp ) ) AND ( TITLE-ABS-KEY ( "Wellbeing" OR "Well-being" OR "Well being" ) AND DOCTYPE ( ar OR cp ) )
13	RI AND I40	0	( TITLE-ABS-KEY ( "Responsible Innovation" ) AND DOCTYPE ( ar OR cp ) ) AND ( TITLE-ABS-KEY ( "Industry 4.0" ) AND DOCTYPE ( ar OR cp ) )
14	RI AND HMI OR HMC	0	( TITLE-ABS-KEY ( "Responsible Innovation" ) AND DOCTYPE ( ar OR cp ) ) AND ( TITLE-ABS-KEY ( "Human Machine Interaction" ) AND DOCTYPE ( ar OR cp ) ) OR ( TITLE-ABS-KEY ( "Human Machine Collaboration" ) AND DOCTYPE ( ar OR cp ) )
15	RI AND A	0	( TITLE-ABS-KEY ( "Responsible Innovation" ) AND DOCTYPE ( ar OR cp ) ) AND ( TITLE-ABS-KEY ( "Automation" ) AND DOCTYPE ( ar OR cp ) )
16	RI AND DSM	0	( TITLE-ABS-KEY ( "Responsible Innovation" ) AND DOCTYPE ( ar OR cp ) ) AND ( TITLE-ABS-KEY ( "Smart Factory" OR "Digital Factory" ) AND DOCTYPE ( ar OR cp ) )

## B.2 Well-being: Working System

This appendix is an extension of **Section 3.2**. It provides a summary of the factors influencing employee well-being. This work follows from literature on Organisational Design [54, Table I, p.591], Human Resource Management [53, Table I, p.297], Ergonomics & Work Design [52, Table 2, p.15] and [59], Governmental Work-Place Research [60, Table I], Health Services [61, Additional File TICD Checklist], and Psychology [47, Table S1].

Factors are classified in the five categories of the Working System: task, technology, environment, organisation, and individual. Factors have been cross-checked across literature to avoid misinterpretations and repetition. Please note the following are not absolute definitions of the factors.

Some factors are straightforwardly defined (e.g., Job Rotation, are employees being rotated? Yes or No). However, some factors are not straightforwardly defined. For example, Work-life Balance: this does not refer to a quantifiable balance of 12 hours work & 12 hours personal life. Rather, this factor comprises intangibles as views and beliefs of managers, and tangibles as policy and activities that ensuring the good balance of work and life.

### B.2.1 Organisation

1. **Career Development** as long-term vision on employee's development, promotion opportunity, and career path programs;
2. **Training & Learning** as short-term vision on employee's development;
3. **Job Rotation** inside the organisation;
4. **Job Security and Continuity** may be reflected on filling vacancy with internal people or recruiting from the outside;
5. **Compensation and Rewards** based on employee performance;
6. **Inclusive Management Practice** refers more broadly to direction and goal clarity, wide organisation transparency, dialogue and employee voice and involvement, concern for workers' well-being;
7. **Job Structure** as division of labour, hierarchy, rules and policies, procedures;
8. **Change Management** as internal and external capability;
9. **Monitoring and Feedback** of internal capabilities, e.g., mechanisms to ensure leaders lead and employees are heard;
10. **Organisational Culture** as in e.g., employees readily embrace new programs or more conservative towards change;
11. **Work-life balance** as short and long term view on employees' balance of work and personal life and family;
12. **Organisational Justice** as fair treatment to employees across the organisation;

### B.2.2 Environment

1. **Physical Environment** refers to noise, temperature, vibration, illumination, ventilation, physical workplace distribution, potential hazards of the environment, and the need for wearing special protective clothing;
2. **Social Environment** includes:
  - (a) **Communication** as transparency and information sharing;
  - (b) **Interpersonal Relationships** as collaboration between team members and their rapport, shared vision, team spirit and team effectiveness;
  - (c) **Supervision & Coordination** as functioning of leaders as protectors of the interests of workers.

### B.2.3 Technology

1. **Nature of Technology** can be either **tangible** or **intangible**:
  - **Tangible** includes hardware in offices as computer screens, smart-phones, and virtual reality glasses; and hand-tools and machinery in factories;
  - **Intangible** refers mainly to software embedded in computer systems.
2. **Technology Design** as the suitability of tangible and intangible technology to fulfil criteria as user-friendliness, reliability, and other design features;
3. **Technology Implementation** as the characteristics of the process of transferring a new technology into the workplace. Elements of the implementation are:
  - (a) **Quality of Evidence** to persuade people to adopt;
  - (b) **Strength and Clarity of Recommendation** as particular to the message containing the evidence;
  - (c) **Cultural Appropriateness** as the social compatibility;
  - (d) **Compatibility with Current Practice**, or technical compatibility;
  - (e) **Consistency with other Guidelines** as part of a larger technology transfer or larger project;
  - (f) **Feasibility** of achieving implementation and intended goal through technology;
  - (g) **Accessibility of the Intervention** as involvement of personnel with the technology deployment;
  - (h) **Effort to Change and Learn** as quantified by organisation;
  - (i) **Trialability** as possibility of pre-testing technology in question;
  - (j) **Observability** of benefits brought by technology.

### B.2.4 Task

1. **Nature of Work** can be **mental** or **physical**:
  - (a) **Mental Tasks** include decision-making, reasoning, planning, scheduling, and estimation activities; information processing and information retrieving activities; sensory and perceptual processes.

- (b) **Physical Tasks** include use of devices and equipment; manipulation and coordination activities; body positions and posture; manual activities and activities which involve other body movements; level of physical exertion, including strength and endurance.

2. **Job Content** includes:

- (a) **Variety of Work** as in a monotonous and repetitive task, or one with variation from cycle to cycle;
- (b) **Task Execution** as in short or long cycles, which may include interruptions or conflicts;
- (c) **Task Extension** as a fragment of a larger work-piece, or the task as a work package on its own;
- (d) **Task Identity** as the extent to which the employee's work contribution is identifiable at the end of the process;
- (e) **Task Complexity** as the match between skills and work demand;
- (f) **Task Workload** as quantifiable by the nature of work;
- (g) **Task Pace** as the speed of execution;
- (h) **Task Meaning** as the extent to which someone's task brings value to organisation and society.

3. **Job Control** includes:

- (a) **Employee's Autonomy** on selecting methods and procedures to execute the task;
- (b) **Group's Task Control** as the group's autonomy to self-manage and coordinate itself;
- (c) **Expected Delivery Level** on shape and quality of the final product;
- (d) **Task Feedback** on execution and completion as given by colleague, supervisor, or machine;
- (e) **Task's Dependability** on work contributions by other employees;
- (f) **Task Uncertainty** on task itself or subsequent work contributions;
- (g) **Workload Control** as decided by the employee;
- (h) **Work Schedule** as the flexibility for distributing work over time;

### B.2.5 Individual

1. **Job Satisfaction** with respect to organisation, level of supervision, team-work, salary and job stability, training and development, individual work;
2. **Job Commitment** to the larger organisation, the supervisor, the working group, or the community. **Job Engagement** is also used as an alternative term;
3. **Psychological Factors** as achievement, autonomy, resilience, personal and intellectual interests, self-esteem and self-efficacy, desire to growth and self-discovery, including sense of purpose and meaning, sense of humour, spirituality, affectivity, other needs;
4. **Mental Health** as anxiety, depression, and mood disorders;
5. **Physical Health** as stress, discomfort, physical pain, chronic illness, physical fitness and vitality;

6. **Sick leave and turnover intention** as intention to leave temporarily or permanently;
7. **Socio-Economic Status** including educational background and income;
8. **Skills** including aptitudes and abilities.

### B.2.6 Commentary on Categories and Factors

The summary provides a non-exhaustive, yet representative sample of factors that influence the functioning of an employee inside an organisation. Additional comments on the summary's structure and the angle from which they have been approached are given below.

1. *Organisation*: The concept is interpreted as the larger enabler of processes, activities, relationships, visions, among others. It can be argued that there is an overlap with the factor communication in the environment and organisation category. However, note that the emphasis of communication in environment is on a specific member-to-member activity, whereas in organisation the emphasis is on the channels of diffusion which keep everyone up-to-date of changes, achievements, etc.
2. *Environment*: In the case of leadership there may be a similar overlap. Namely, in environment the focus is on the specific interaction of employee and supervisor, or leader. For the case of organisation, one takes a step back and appreciates the mechanisms, activities, and resources that are in place in the organisation which nurture the relationship between actors and enhance the quality of their interactions.
3. *Technology*: The concept of Technology Design is loosely used for including multiple design requirements a system may have. In the scope of this study, it can be taken to capture the characteristics of the human-machine interaction. Further, there is an overlap between some of the design requirements above and the Technology Implementation guidelines. For instance, the factor of compatibility can have a different unit relative to a given tool or a as part of a sub-system. However, note that in Technology Design one dives into the technology software or hardware, whereas in Technology Implementation one takes a step back and appreciates the process.
4. *Task*: Arguably, there is no pure physical work without mental awareness. In the interest of simplicity, combinations thereof are not considered
5. *Individual*: In the technology category, Technology Implementation includes factors focusing on the process as intended by the organisation. In the individual category, these factors are studied from a different angle which 'redefines' them into:
  - **Awareness and Familiarity**
  - **Knowledge about own Practice**
  - **Skills needed to adhere**
  - **Agreement with the Recommendation**
  - **Attitudes towards Guidelines**
  - **Expected Outcome**
  - **Intention and Motivation**
  - **Learning Style**
  - **Capacity to Change**
  - **Self-monitoring or Personal Feedback**

### B.2.7 Links WB Factors and I40 Areas of Concern Clarification

This is an extension of **Section 3.5**. The connection between the selected 16 Working System factors and the 5 Areas of Concern are articulated through questions. These can be found below in **Table B.5**. Each factor is linked to two areas; number 1 and 2 show these connections. A number 1 indicates a prominent connection, and 2 a secondary. The ranking is based on the clarity of the connection as considered by the author. These are not absolute connections and are only meant to present an initial case for the study's SRQ2.

Table B.5: Clarification. Connections between Well-being Factors and the 5 Areas of Concern of Industry 4.0

Category	Factor	A1	A2	A3	A4	A5	See Comment
<b>Organisation</b>	Career Development & Training	2	1				1
	Compensation and Reward	1				2	2
	Inclusive Management Practice	2				1	3
	Monitoring and Feedback	1			2		4
	Organisational Culture	2			1		5
<b>Environment</b>	Team Communication	2	1				6
	Supervision & Coordination	2	1				7
<b>Technology</b>	Design				1	2	8
	Implementation			2	1		9
<b>Task</b>	Variety		2			1	10
	Workload			2		1	11
	Complexity		1		2		12
	Identity			1	2		13
	Autonomy & Dependability	1		2			14
	Uncertainty		2		1		15
<b>Individual</b>	Job Engagement			1		2	16

1. How forms of training are designed based on various user profiles?; How are education models updated based on Industry 4.0 input?
2. How are current reward schemes perceived by users?; How have reward mechanisms been updated based on the input of X actors?
3. What cultural values in the organisation reflect inclusion of users for strategy development?; How are these values communicated and reiterated across groups?
4. How effective have been mechanisms in controlling actions by leader in smaller units?; What feedback has been received on non-captured feedback by current sharing platforms?
5. How effective has been the company vision according to users on communicating future actions of the organisation?; How does the perception and attitude towards new technologies differ in A or B unit?
6. What models of collaboration are currently being encouraged?; What does feedback tell us on the performance of digital groups?
7. How does training packages differ for training on the various forms of leadership?; What forms of leadership are identified in the organisation and how are they being monitored?
8. What combination of disciplines are commonly part of the design process?; What determines an inclusive sample for testing of new tools?
9. What feedback has been received on late training or involvement actions?; What actions are currently reviewing the implementation methodology?



10. What is the company view on job rotation?; What obstacles have been expressed on combining rotations and training?
11. How can fluctuating workload be best allocated based on user's profile?; How can fluctuating personal motivations be best captured for task allocation?
12. What trainings currently prepare employees on independent decision-making?; How is complexity of task specified during the tool design to respond to various skills of users?
13. How have been particular skills (digital handcraft) mapped inside the organisation?; How have they been rewarded?
14. What feedback has been given on processes hindering collaboration?; How employee interaction across units can best benefit a user's work and profile?
15. What activities are preparing users to cope with the inherent uncertainty of new tools?; How foresight activities address abstract elements in the design of tools?
16. What channels does the practice use to communicate change benefits as a fresh source of job engagement?; How are various motivations understood and managed by managers in organisation?

## B.2.8 Supporting Diagrams

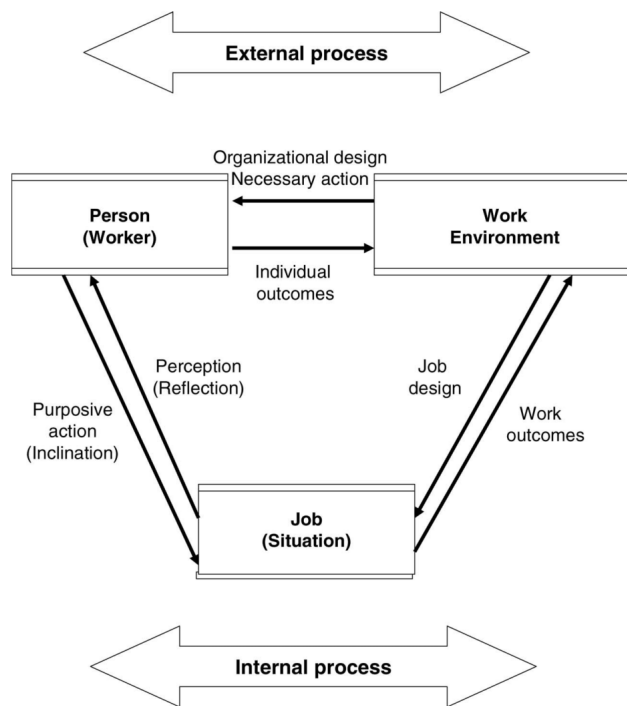


Figure B.1: Working System Depiction as presented by Genaidy et al. [52]

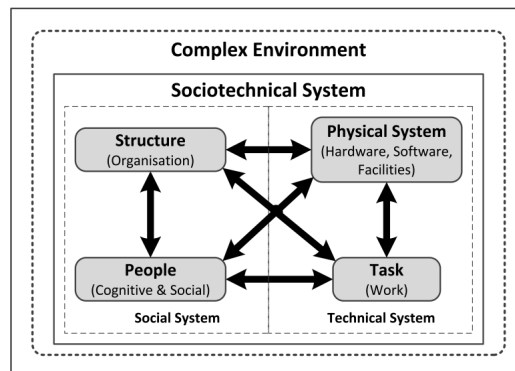


Figure B.2: Socio-Technical System Depiction as presented by Oosthuizen and Pretorius [57]

# Appendix C

## Ch.4 Results: Corporate Case

### C.1 Data Collection in Company: Documentation Analysis

#### C.1.1 Organisation Documentation Analysis

This is an extension of **Section 4.5**. The coverage of the company's current efforts is not extensive. Efforts are not named after their original name in the company, and their descriptions are written in high-level, general terms. This is done due to corporate confidentiality.

1. **Digital Strategy:** refers to clear top-level communication campaign shared across functions through the unified information platform. Messages shared are relevant and convey clear direction of organisation with respect to new digital projects. Future path articulated to employees with what change of mentality is needed, for instance, by diving into what means to be entrepreneurial and disruptive.
  - **Digital Employee** is part of the strategy and includes various initiatives that encourage employees to go mobile, get connected, be social, work smart, meet and share. Online platforms are increasingly important in supporting sharing and co-creation activities.
2. **Education Platform** offers multiple voluntary and mandatory trainings in areas as Safety, Ethics Business, Information Security, Lean-Six Sigma for Beginners, among others. Recently, a new platform has been launched to incorporate learning and talent management as well as information-sharing and collaboration. This allows employees to track training, create a personal development plan, and engage in learning communities. The learning model has a strong emphasis on continuous, social, and informal interaction, whereas the emphasis on formal and periodic learning is limited.
3. **People Focus** is an initiative focusing on talent and performance management. It builds on various activities that support: goals and outcomes alignment; learning and development; dialog and feedback; reward and recognition. It serves as a large effort to ensure activities support employees in what learning they should consider next and how to do this. A prominent example is:
  - **Employee-Supervisor Dialogue** is an initiative to encourage supervisors and employees to meet in frequent intervals during the year. Content of the meetings revolves around employee well-being which is defined as “way of thinking that guides attitude, choices and actions.” Employees may voice out difficulties and work challenges; supervisors can provide feedback on performance and address timely issues concerning project and career development. This initiative benefits actors in this way:
    - **Employees:** they take more ownership on professional growth and development. A possible result of meetings is tailoring one's work to reflect on knowledge and skill building to tap one's true potential.
    - **Line Manager:** it builds a stronger, trust-based relationship with employees through more active coaching. In addition, formal performance reviews

are easier for managers, as there are no surprises. Finally, it reinforces the leadership credibility of managers.

- **Team:** these meetings allow for the articulation of roles and expectations from employees inside their teams. This strengthens team-work and network. In addition, meeting may promote cross-functional collaboration.
- **Company:** such initiatives demonstrate the organisational commitment towards developing employees and facilitating knowledge transfer. This increases human capital retention thanks to higher employee engagement.

4. **Organisation Project Methodology:** is the guiding methodology used across the organisation, which covers topics as project management, management of change, and process engineering aspects. In particular, the change dimension addresses the management of stakeholders, people in process implementation, training, communication and change measuring. Guidelines are flexible and can be tailored according to the project's size, complexity, budget, and risk level.

5. **Well-being Campaign:** The concept is defined inside the organisation through its six elements:

- **Work** defined in terms of nature of work, the social interactions enabled by work, and work variation and rotation;
  - **Leadership** includes roles of leaders and self-management;
  - **Work Community** refers to open communication, the support of a good working atmosphere, and the prompt intervention in conflict;
  - **Competence and Motivation** refer to meaningfulness of work, fairness and opportunities to create, and open communication and constructive feedback;
  - **Health** as in safe and healthy working;
  - **Life Situation** refers to the balance of personal and work life.
- (a) **Life Saving Rules** it is part of the larger well-being campaign and focuses on safety values and their importance to corporate culture. The campaign has an interesting angle on well-being: *stay-well* through supporting the culture creation; *manage-well* one's own responsibility for achieving goals without compromising on health, safety and well-being; and *be-well* as further professional support to assist on what to do to be well.
- (b) **Healthier Together** also forms part of the well-being campaign and reinforces the culture creation by making use of owned technology, health-trackers. This has the purpose of encouraging a healthy lifestyle among employees. It represents a competition for teams worldwide and highlights the benefits of digital health to employees.

### C.1.2 Extension of Factory Documentation Analysis

1. **Filter Journey:** filtering is a complex task performed by operators as part of the production process. It has been described as a “mixed of art and science” for its demand of technical knowledge and manual dexterity by the operator. Quality in filtering is taken as a big source of pride among employees and there are various ways the organisation awards employees for their contribution: a wall of fame in where top filter-tuners are displayed; a personal award badge carried by each filter tuner; the opportunity to train in situ new employees as part of the tuning school; the opportunity to share best practices for tuners from other global factories.
2. **Conscious Factory Wall:** future projects are displayed on a wall at the factory’s entrance which can be revisited by employees every day. This is coupled to active communication regarding the benefit of new projects for everyone’s daily tasks. In addition, information sessions are organised for clarifying the implications of new programs and to gather input from employees on the direction of the factory and how it could be improved.
3. **Health Sessions:** in addition to medical campaigns, active lifestyle and stress-free work campaigns including Tai-Chi, Qijong and Yoga sessions have been organised for all employees.
4. **Corporate Social Responsibility (CSR):** various programs are organised around sensitive subjects as: child and forced labour, fair treatment inside and non-discrimination, working hours, compensation and benefits, freedom of association and right to collective bargaining, business ethics and anti corruption, and environmental management.
5. **Virtual Tour:** interested parties from inside and outside the organisation can have a virtual tour of the facilities and learn more about current and future efforts in the factory.
6. **World Safety Day:** top management has actively joined information campaigns on zero tolerance and saving lives rules inside the factory.
7. **Vision:** it includes a) fully automated (how to assuage people’s view that they won’t be replaced); b) self-learning (how does the human knowledge add value to what the factory can achieve?)
8. **Key Performance Indicators (KPI):** multiple KPIs have been specified in the factory to reflect importance on well-being aspects. These include: number of safety incidents, results of employee engagement survey, number of people engagement programs, improvements in competence development; number of CSR activities, regulatory compliance, and society perception.
9. **External Best Practices:** factory actively interacts with other manufacturers in the region to improve current practices and create altogether better impact on surrounding society.
10. **Education Training:** factory has own academy aimed to train employees in various technical and managerial areas.
11. **Pipeline Projects:** multiple projects inside the factory are meant to improve employees well-being. For instance, smart cap for measuring employee stress, smart gloves for better task execution, and other smart wearables for health monitoring.

### C.1.3 Research Agenda: Inquiry on Organisation Project Methodology

The analysis of the documentation on the PM methodology triggers further questions on how it actually is used in practice.

1. An initial action is that of defining the steering team and assigning other stakeholders, **what criteria are used for deciding that various stakeholders are sufficiently represented in the steering team?**
2. At PM1 the detailed project planning is approved and completion criteria are listed, **are well-being considerations as user satisfaction part of these criteria?**; These criteria reflect on the business case benefits; arguments on well-being as benefits should be linked when possible to metrics, target values, or some form of measure for its acceptance.
3. **How is time and money budget used for exploration of risk activities?, and how is the risk analysis defined?**
4. The schedule of a project is specified and in the event that something goes slightly off-curve, **what considerations are used for determining the buffer time?**
5. Change management is explicitly addressed as part of the process; it implies that “all relevant stakeholders are informed about the targets and status of the project, understand the needed changes and are committed to sponsoring the goal.” This may be a traditional top-down view on change, **how are these goals realised with user feedback and how are their achievement assessed?**
6. A reasonable approach for communications and stakeholder management is recommended, **what is reasonable defined from user to user?**
7. In addition, the label of stakeholder management is used, **how is this concept, its enabling tools, and its implications understood by various users?**
8. **How are guidelines for usability and end user testing defined?**
9. **To what extent can team members co-create their assigned roles?**
10. Training are delivered to end users at PM3-PM4, **how did users provide early input on the training material?**
11. “User acceptance to verify the suitability of the solution” comes at PM4. This may be too late and expensive to change a tool, **how are costs analysed at this stage?**
12. “Legal compliance should be ensured before beginning of deployment”, **how and when are considerations of new projects e.g., data privacy discussed and negotiated with the workers’ council?**
13. In PM5 the training of end users is finalised and qualified, **what criteria determine a poor employee qualification?**

## C.2 Data Collection in Company: Interview Protocol

This is an extension of **Section 4.3** and **4.4**. The protocols are used to guide the interviews.

### C.2.1 Interview Protocol for Round I

This interview contributes to a master thesis project. The project aims to identify well-being concerns on the implementation of automation projects in [specific domain of company]. More specifically, the goal is to understand how the well-being of employee's is managed in practice. Well-being is a broad concept but for the interview's sake it focuses on enabling physical, psychological and social positive states of an individual in the work environment. With your contribution I will recommend actions for ensuring an organisational practice that considers employees in this regard.

The interview is not recorded but notes will be taken. It lasts [45 minutes] and contains [13] question. After the data has been transcribed and analysed, your answers will be shared back with you in order to confirm that what has been said has been correctly interpreted. Nothing will be published without your approval. Should there be corrections or omissions concerning the answers, these will be done. Do you have any other question or remark before we start?

1. In what department do you work and what is your role?
2. How is your department affected by the current organisational transformation?
3. Please specify the transformation activities or milestones your department has gone through in [specific period of time]?
4. How does the PM methodology assist managers in your department during these transformation activities?
5. What shortcomings have been expressed regarding the current methodology?
6. How are lessons learnt from the deployment of new programs shared?
7. How are employees informed and prepared for the execution and implementation of [given program]?
8. How are the views from employees before and after the program captured? How is action taken upon their feedback?
9. How are employees without the necessary skills, diverse background, trained and incorporated into the new program? How adequate is the workplace for their needs?
10. How are reward and career development program currently addressing the various motivations of employees?
11. How is engagement with new programs and learning evaluated?
12. What difficulties in relation to employee well-being do you foresee in future implementation programs?
13. Do you have additional comments on the various subjects discussed today?

### C.2.2 Interview Protocol for Round II

In our last interview we discussed various aspects of the deployment of new programs in your department. You received from me a summary of the answers from the interview and you confirmed that your answers were interpreted correctly. From the initial input I recognised four clusters of inquiry. Today's interview lasts 45 minutes and is structured around these four areas. The interview is not recorded, but I will take notes that will be later shared back with you.

1. The first area is the need for a review on the alignment of departments to strategise and provide development resources to employees, including training capable leadership. **How do you find their current alignment and what are the next steps for improving the alignment?**
2. The second area is the need for a review on the inclusion of change management aspects in early process stages, including involvement of users and interaction with external sharing practices. **How do you find this inclusion of change management aspects and what are the next steps for their improvement?**
3. The third area is the need for a review on the sharing practices across groups and need for effective codification of learnings for enriching process methodologies across groups. **What are your concerns on current sharing practices and what are the next steps for their improvement?**
4. The fourth area is the need for a review on the view from reactive to proactive on the role of continuous improvement and their interaction across units. **How do you find the role of continuous improvement and what are the next steps for its improvement?**



# Appendix D

## Ch.5 Discussion

### D.1 Opportunities & Obstacles for Responsible Innovation

### D.2 RI Opportunities

This is an extension of **Section 5.2.1**.

Table D.1: Clarification. Opportunities for Responsible Innovation in the Study of the Areas of Inquiry

Categories	Areas of Inquiry	Ant.	Resp.	Incl.	Ref.	See Comment
<b>Organisation</b>	Learning Pillars	2		1		1
	Recognition and Visibility of Expertise			2	1	2
	Interaction with External Actors	2		1		3
<b>Environment</b>	Transparency of Change Learning		1		2	4
	Leadership Capability		1	2		5
<b>Technology</b>	Change Aspects in Implementation	2		1		6
	Continuous Improvement Capability		2		1	7
<b>Task</b>	Concerns on New Forms of Work	1		2		8
<b>Individual</b>	Professional Identity			1	2	9

1. What activities are currently mapping the preferred ways of learning and what difficulties has the group shaping new trainings had with respect to mapping?; How are use-cases (examples) of traditional skills used to develop new learning packages?
2. How effective have been recognition mechanisms in awarding various performance profiles and how are these mechanisms perceived in units (based on X survey or data collection)?; What activities are used by subject experts to share project knowledge outside their units have units documented how success cases of collaboration with these external subjects experts?
3. What current training or education session on Intellectual Property (Project Seed Protection) is offered to employees?; What does the current strategy say on the balance of open innovation and non-disclosure, confidential projects and how has this been communicated?
4. What methodology (recommendation) has the central change group given to project level units to capture and share knowledge?; What reasons does a manager have to define the knowledge sharing process of this unit in that particular?
5. What feedback has been received on the PM methodology's flexibility for leaders to drive change? and What difficulties have managers experienced in responding to unexpected situations in projects?; How have the various forms of leadership mapped in the organisation and how their profile description shapes trainings and communication?
6. What (foresight) activities are preferred by X leaders to gather input and test new tools?; what input has been given on the PM methodology's ability to specify inclusion of change aspects at different stages?

7. What feedback has been received on the continuous improvement strategy to transfer capability to project units?; What cases have been gathered to show the use of CI in projects of varying urgency?
8. How is X group currently gathering input on digital presence of employees to modify structures?; What collaboration cases between R&D (technical, IT) and business groups for new tools can be identified?
9. How does the current communication reflect on various views upon work-life balance?; How do current structures capture feedback from employees on new motivations influencing their performance?

### D.3 RI Obstacles

This is an extension of **Section 5.2.2**.

Table D.2: Clarification. Obstacles for Responsible Innovation in the Study of the Areas of Inquiry

Categories	Areas of Inquiry	DS	IA	WP	MP	See Comment
<b>Organisation</b>	Learning Pillars	X			X	1
	Recognition and Visibility of Expertise	X	X			2
	Interaction with External Actors	X	X			3
<b>Environment</b>	Transparency of Change Learning	X			X	4
	Leadership Capability		X	X		5
<b>Technology</b>	Change Aspects in Implementation		X		X	6
	Continuous Improvement Capability	X			X	7
<b>Task</b>	Concerns on New Forms of Work			X		8
<b>Individual</b>	Professional Identity	X	X			9

1. How should various learning preferences in the organisation be taken into account when developing new trainings?; How should continuous education be encouraged among senior employees?
2. How should varying performance among digital employees be best monitored and assessed inside the organisation?; How should management prevent protectionism of expertise inside a unit?
3. How should management balance open innovation and intellectual property?; What new forms of external collaboration should the organisation consider?
4. How should management best capture, document, and share lessons-learned across groups?; How should management motivate employees to adapt their knowledge sharing techniques?
5. How should leaders be trained to balance project protection and knowledge exchange?; What additional forms of leadership will the digital enterprise require?
6. How should the organisation actively support top-down and bottom-up change?; What additional activities should be in place to ease the technology adoption by senior employees?
7. How should the different continuous improvement methodologies be best adapted to fit diverse units across the organisation?; What advantages would a decentralised continuous improvement function bring to employees?
8. What range of activities help the organisation to anticipate undesired scenarios of new projects?; What are the unknown unknowns of the project/technology in question?
9. How should management increase the transparency of the dialogue between employer-employee?; How is management currently investigating and taking action upon evolving employees' motivations?



