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Competencies necessary to improve the ability of organisation to design sustainable futures

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Abstract: *The paper explores how organisations can improve the way they think about sustainable futures. The aim is to help manufacturers understand how to plan for futures that need to be radically different from the business as usual trajectory. This article proposes a competency assessment framework that can be used by entrepreneurs to assess their organisations transformation progress towards a sustainable industrial system and develop actionable responses to sustainability challenges. The paper reports the results of exploratory case studies observed through document analysis and interviews. A case study methodology was utilised to gain improved understanding of key competences and those factors that substantially influence the success of such efforts. The cross sector case company analysis offers findings on what other organisations have done to improve sustainability performance. It is found current-planning techniques may not be adequate to help envisage and prepare for radically different sustainable future. The challenge observed is that organisations don't have a common language for talking about the system for system level planning. The framework provides a common language to help manufacturers navigate the radical changes necessary to move towards sustainable industrial systems. The case study findings provide insights into what is important to practitioners in planning for a sustainable & resilient future.*

Keywords: *Whole system design, system thinking, Industrial sustainability, co-ordination, resilience*

1.0 Introduction

The Foresight report on the future of manufacturing, states 'manufacturing in 2050 will look very different from today, and will be virtually unrecognisable from that of 30 years ago' [1]. The report states that manufacturing is set to enter a dynamic new phase, driven by rapid changes in technology, new ways of doing business, and potential volatility around the price and availability of resources. It predicts a

manufacturing sector that is faster, more responsive and closer to customers, more sustainable and built on a more highly-skilled workforce. The author argues, the business as usual approach is becoming evident will not deliver a sustainable outcome. Senge [2] states that the un-healthiness of the world today is in direct proportion to our inability to see it as a whole. Organisations are focusing on sustainability as an objective, but they are largely limiting their efforts to what can be done within the boundary of the firm [3]. Industrial Sustainability will encourage new configurations of the industrial system. Organisation lack understanding in how to plan for futures that need to be radically different from the business as usual trajectory. This research explores capabilities needed for understanding how industry can bring environmental and social sustainability concerns into its design and manufacturing practices, with a duel emphasis on urgent & practical change now and system level change that offers hope for transformation to a sustainable future.

1.1 Research aims & objectives

The aim of the research is to improve the way organisations think about sustainable futures. The objective is to identify key competences for industry actors to focus efforts to plan transformation to a more sustainable industrial system. It is found, current-planning techniques may not be adequate to help envisage and prepare for radically different sustainable futures. The paper investigates,
research question: 'What are the key competencies necessary to plan for a sustainable future? More specifically there is a need to better understand what enablers are needed to unlock system performance.'

2.0 Research method

To investigate the research question, a two-phase research method was designed as illustrated in figure 1.

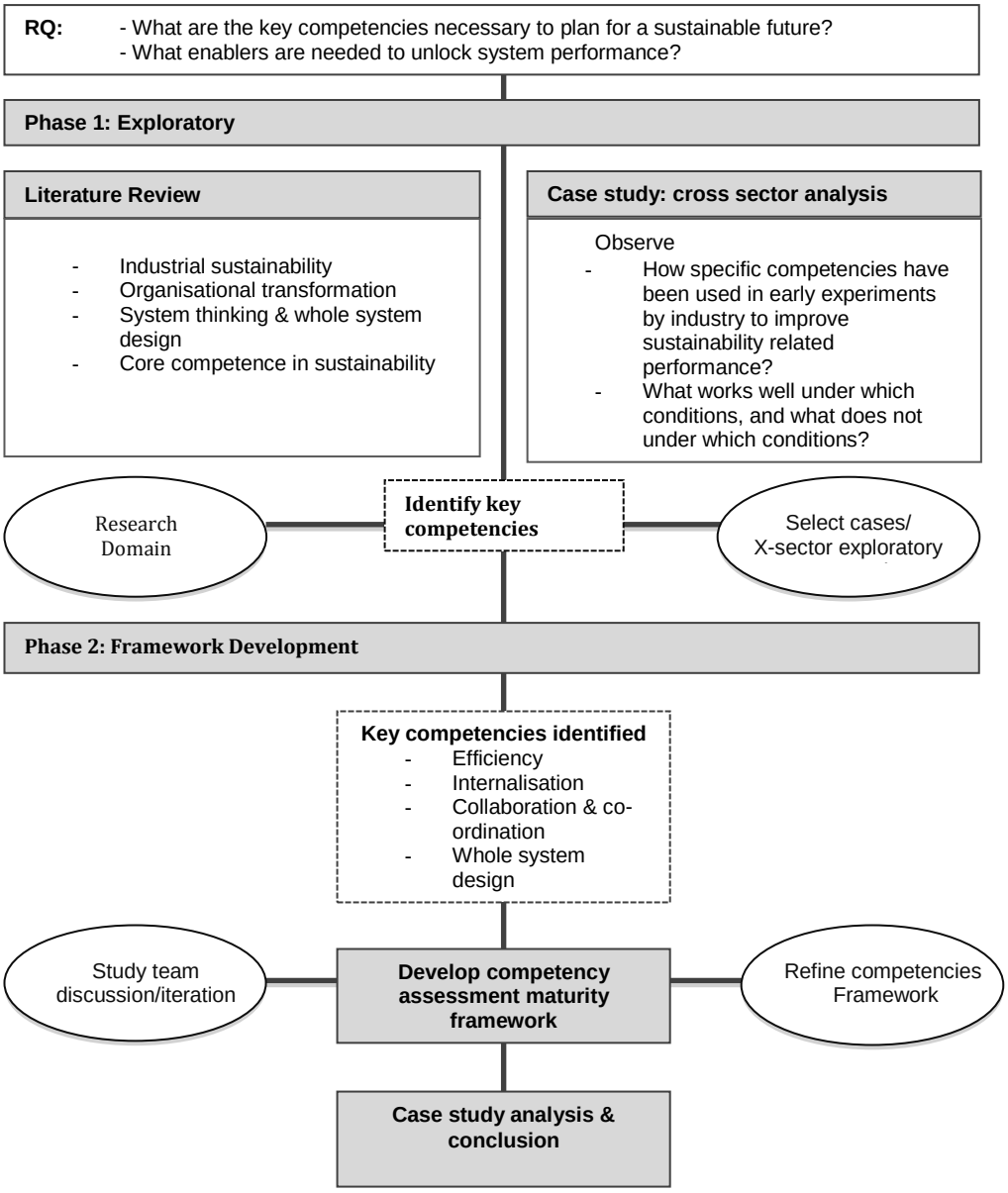

Figure 1. Research method

Phase one is an exploratory phase, which consists of literature review and case study analysis. The literature review explores 4 research domains; industrial sustainability, organisational transformation, system-thinking & whole system design and core competence in sustainability.

The research investigates; what are the key competencies necessary to plan for a sustainable future? And more specifically, what enablers are needed to unlock system performance?' The literature review highlights current knowledge and gaps in the literature that the current research contributes towards. The cross sector case study is used to observe and identify key competences used by industry actors to transform to a more sustainable industrial system.

The key competencies are identified by observing;

- How specific competencies have been used in early experiments by industry to improve sustainability related performance?
- Exploring, What works well under which conditions, and what does not under which conditions?

Additionally the researcher experience from previous research on projects such as eco-efficiency, eco-factory, sustainable industrial systems aid in identifying the competencies.

Due to the significant focal firm engagement required, and the complexity associated with the broad scope and data set to be reviewed, a case study analysis was deemed appropriate as a research method. Five case studies are selected. It is appropriately applied when research addresses exploratory questions and aims to produce a first-hand understanding of complex phenomena. Interviews and observations were selected as the primary techniques for this research due to the depth of understanding of the subject that this can capture; company maturity within the broad area of industrial sustainability and access were also important. The use of multiple data collection instruments within the research methods assisted with triangulation of data, thereby strengthening the qualitative outcomes of the research. The applied data collection tools include semi-structured interviews with open questions plus documentation reviews. All interview notes were sent immediately for comment, with further analysis fed back to participants. The approach was set up to ensure that there is both a discussion and consistent output across the case study firm. Finally, the data set was further reviewed against secondary data from published reports. The epistemological positioning of the research and case study protocol used in this research meet the validity strategies suggested by Creswell and Miller [4] including triangulation, member checking and the audit trail. Multiple case studies are included to increase the explanatory power of the data collection process [5]. The case studies chosen to review the industrial sustainability frameworks have unique business strategies, with complex multi-domestic footprints and some level of published sustainability credentials (i.e. that might support advanced sustainability performance). In

addition, data availability and accessibility were determinant factors in the case selection process.

Phase two is the competency assessment framework development stage; the framework was developed by mapping the knowledge gained from phase one of the research. Competencies identified was mapped onto a maturity matrix. Building theories from case studies relies on theoretical (as opposed to statistical) sampling [6]. Given the limited number of cases that can be studied, it is important to select critical, extreme and revelatory cases, in which the phenomenon is 'transparently observable' [4]. Frameworks help interlink concepts on a common plane to thereby provide a comprehensive understanding of the phenomenon in question [7] Furthermore, a multiple-case design is appropriate when the purpose of the investigation is theory description, theory building or theory testing. Yin [8] states, 'Multiple-case studies should follow a replication, not sampling logic'.

3.0 Literature review

The following bodies of the literature are considered pertinent to the aim of this article: sustainable industrial systems, organisational transformation and system thinking & whole system design.

3.1 Sustainable industrial system

Robèrt & Lovins [9] draws a picture of the 'next industrial revolution' being based on four strategies; radically increased resource productivity, redesigning industry based on biological models with closed loops and zero waste, shifting from the sale of goods to the provision of services, and reinvesting in natural capital. The authors argue that the growing scarcity of natural resources will act as the catalyst for the next industrial revolution in a similar way that the scarcity of human resources drove the logic of the first industrial revolution. Graedel & Allenby [10], McDonough & Braungart [11], Robèrt & Lovins [9] state that significant changes to the way we think about the industrial system are needed in order to make it sustainable. It is argued that it is essential to look at the entire system of designing, making and serving to achieve the level of environmental performance change that is needed (Senge [12]). From an industrial design perspective this means developing materials, products, supply chains, and manufacturing processes that replace industry's linear business (make-produce-sell-use-throwaway) model and transform to a closed loop business model (cradle-to-cradle) [11].

Ecosystems are properly termed 'systems' in part because energy and materials flow between and among trophic levels" [13]. Industrial Ecology (IE) is a metaphor for how industry can learn from observations about how species interact and

materials flow within natural ecosystems and at the higher system level the biosphere (Frosch and Gallopoulous [14], Ayres [15], Scolow [16]; Clift [17]; Deutz [18] and Gibb [19]). Its aim is to align industrial processes with 'material flows in living systems' [20], through the reorganisation of firms into 'industrial ecosystems' [19]. Thomas et al [21] highlights the three specific dimensions of the industrial ecology metaphor put forward by both Frosch and Gallopoulous [14] and Ayres [15] as; the optimisation of energy and materials within an industrial system; the minimisation of waste and the exchange of by-products from one production process as an input in another [21]. The key concepts that emerge from industrial ecology is the idea of the waste or the output of one organism in nature being the input or food for another organism namely the idea of 'waste equals food'. However, Braungart et al. [22] also emphasises the fact that the concept of waste does not even exist in nature at all. The idea of designing out waste goes beyond the concept of de-materialization – merely doing more from less material input [22], to designing out aspects of products or industrial processes that produce outputs that cannot be cycled and re-used safely in the techno sphere Robért [9] as technical nutrients or enter the biosphere as biological nutrients [22]. It appears that resource constraints and environmental concerns such as water scarcity together with other factors will influence the potential location of our factories and the business models they operate in the near future. Concepts such as circularity, systems thinking and whole system design are proposed in the sustainability literature as providing compelling principles on which future industrial systems might be built. However application of these models is scarce, and practitioners lack understanding of capabilities needed for planning for such transformation to sustainable industrial systems.

Fernando [23] provide an in-depth review of existing Industrial Sustainability frameworks available to business decision makers and provide analysis of existing frameworks strengths and weakness through the lens of the case study. The paper illustrates, sustainability frameworks by pioneering authors help managers and decision makers to shift their attention from eco-efficiency (less bad) to eco-effectiveness (more good). It also highlights for businesses to put the sustainability framework into practice they need both the right technologies and the right strategies, and capabilities. Which implies a need to collaborate with different actors & stakeholders across the system, and sustainability frameworks identified was found to help inspire new thinking and improve shared understanding through structured discussions with other actors in the system.

3.2 Organisational transformation

Pettigrew [24] proposes a method to investigate and study strategic transformation,

it appears transformation could be looked at as; content, context, and process. Pettigrew [24] defines content as the particular areas of transformation under examination ("what" of change). Thus the firm may be seeking to change technology, manpower, products, geographical positioning, or indeed corporate culture. The context (the "why" of change) of transformation is defined as the outer context, which is concerned with the macro & microenvironment within which the organisation operates, and the inner context which is concerned with the structure, corporate culture, and political context of the organisation. The process (the "how" of change) refers to the actions, reactions, and interactions from the various interested parties as they seek to move the firm from its present to its future state [24]. Pettigrew and Whipp [25] further emphasise that successful change is a result of the continuous interplay between the three dimensions (context, content, process).

3.3 System thinking & whole system design

Seiffert and Loch [26] suggest that the most important property of systems is that they are made up of several parts that are not isolated, but closely interlinked, forming a complex structure. Systemic or systems thinking, facilitates the improved understanding of these complex systems and enables the identification and utilisation of interrelationships and linkages as opposed to things. Systems thinking is a technique for investigating entire systems, seeking to understand the relationships, the interactions, and the boundaries between parts of a system [26]. Systems thinking is particularly well suited to modeling highly complex open-systems where an integrated understanding is required at both the micro and macro-levels in order to predict or manage change. This contrasts with the dominant analytical approach of the physical sciences, which is based on reductionism, analysing closed-systems at the level of their constituent parts and then simplifying to draw out general conclusions. Systems thinking is a generic term that spans a range of more than 20 tools and methodologies [27].

The Rocky Mountain Institute [28] define whole system design as 'optimising not just parts but the entire system ... it takes ingenuity, intuition, and teamwork. Everything must be considered simultaneously and analysed to reveal mutually advantageous interactions (synergies) as well as undesirable ones'. Whole-systems thinkers see wholes instead of parts, interrelationships and patterns, rather than individual things and static snapshots. They seek solutions that simultaneously address multiple problems [29]. Lovins [29] are among the small number of authors who suggest that understanding the dynamics of a system is integral to the whole system approach. The Rocky Mountain Institute [28] highlights systems thinking as the method that should be utilised not only to point the way to

solutions to particular resource problems, but also to reveal interconnections between problems, which often permits one solution to be leveraged to create many more.

Meadows [30] lists nine places to intervene in a system, in increasing order of impact: numbers (subsidies, taxes, standards), material stocks and flows, regulating negative feedback loops, driving positive feedback loops, information flows, the rules of the system (incentives, punishment, constraints), the power of self-organisation, the goals of the system, and the mindset or paradigm out of which the goals, rules, and feedback structures arise.

"Whole-systems thinkers see wholes instead of parts, interrelationships and patterns, rather than individual things and static snapshots. They seek solutions that simultaneously address multiple problems" [30]. It is understood that there are multiple factors that influence the success of a whole system design process; identification of relationships between parts of a system to ultimately optimise the whole, and the need for actors involved in the process to develop trans-disciplinary skills and the dynamics of a flattened hierarchy, ability to think holistically and to view the bigger picture. Anarow [31] recognise that the approach focuses on interactions between the elements of a system as a way to understand and change the system itself. Whole-systems thinking pays close attention to incentives and feedback loops within a system as ways to change how a system behaves [2]. Without this whole system perspective crucial impacts between components could be missed, therefore disrupting the system as a whole.

3.4 Core competence in sustainability

The literature on competencies broadly and competencies in sustainability in specific comprises of a variety of terminological ambiguity, authors have linked the term ''competencies'' with abilities, capabilities, roles, experiences and other concepts [32]. Boyatzis [33] and McLagan [34] are some of the early investigators of competencies. Recently in the last decade, there has been interest in conceptualizing key competencies in sustainability (Byrne [35]; De Haan [36]; Barth [37]; Sipos [38]; Segalas [39]; Willard [40]. Dentoni [41] proposes a framework consisting of seven competencies required for professionals who are actively involved in dealing with sustainability in their work environment;

- Systems thinking competence: the ability to identify and analyse all relevant (sub) systems across different domains (people, planet, profit) and disciplines, including their boundaries. Systems thinking competence is the ability to understand and reflect upon the inter-dependency of these (sub) systems, including cascading effects, inertia, feedback loops and

accompanying cultures [42].

- Embracing diversity and interdisciplinarity competence: the ability to structure relationships, spot issues, and recognise the legitimacy of other viewpoints in business decision making processes; be it about environmental, social and/or economic issues. It is the ability to involve all stakeholders and to maximise the exchange of ideas and learning across different groups (inside and outside the organisation) and different disciplines [36]; [43]; [44].
- Foresighted thinking competence: the ability to collectively analyse, evaluate, and craft "pictures" of the future in which the impact of local and/or short term decisions on environmental, social and economic issues are viewed on a global/cosmopolitan scale and in the long term [42].
- Normative competence: the ability to map, apply and reconcile sustainability values, principles and targets [42].
- Action competence: the ability to actively involve oneself in responsible actions for the improvement of the sustainability of social-ecological systems [36]; [45]).
- Interpersonal competence: the ability to motivate, enable, and facilitate collaborative and participatory sustainability activities and research [42].
- Strategic management competence: the ability to collectively design projects, implement interventions, transitions, and strategies for sustainable development practices. This domain involves skills in planning (e.g., design and implement interventions), organising (arranging tasks, people and other re- sources), leadership (inspiring and motivating people) and control (e.g., evaluating policies, programmes and action plans) [36]; [42].

Senge [46] proposes three core-learning capabilities; seeing systems, collaborating across boundaries and creating desired futures for systemic change. The author argues that these capabilities are needed for creating regenerative organisations, industries and economies and states that if you take away one the whole fails. The authors agrees with this view that without the capacity to see systems and their place in them, people and organisations will naturally focus on optimising their piece of the puzzle rather than building shared understanding and a larger vision. Senge [2] explains that 'systems thinking' is a discipline for seeing wholes. It is a framework for seeing inter-relationships rather than things, for seeing patterns of change rather than static snapshots. It appears that system thinking is a way of approaching problems: rather than applying a strict linear methodology, the techniques are iterative, and designed to stimulate investigation, discussion and debate by encouraging multiple perspectives. Systems-thinking does not aim to provide quantifiable answers to specific problems, but rather provides a range of options and better understanding of the implications of those options [28].

From the literature reviewed it appears there is a lack of evidence on how manufacturing practitioners are using these competencies. The use of system thinking and whole system design competencies appear to be essential competencies for systemic change. However, there is a lack of knowledge and literature on what works and what does not work, and which competencies are used by practitioners to plan for a sustainable future. There is a need to better understand what enablers are needed to unlock system performance.

4.0 Case study analysis and findings

This section presents the findings from the case study analysis and interviews. Results are from exploring how the case study organisation have each by focusing efforts on key competencies have been able to improve sustainability performance.

4.1 Case studies explored

Company	Competency Identified	Details
Case A	**Efficiency competency**	A well-reputed automobile company with a global footprint, known for its sustainability credentials industry-wide and for its ability to reduce waste. The company has been able to achieve zero waste to landfill, waste water recycling and 75% reduction in energy to make each vehicle. The automobile company was able to reduce their energy bill by seeing waste better, they used their expertise (the kaizen muscle) to systematically reduce their energy. The company is found to have by setting challenging targets to reduce environmental impact able to find creative ways to recycling wastewater, sending zero waste to landfill.
Case B	**Internalisation competency**	The company is a fast moving consumer good (FMCG), Sugar manufacturer. The company aims to transform all raw materials into sustainable products. The case company has been able to find ways of internalising and being very effective at it. The company converts raw beet to sugar and the byproducts are used to produce electricity, tomatoes, animal feed, and other materials. No

		material arriving into the company is allowed to disappear as waste (and a cost). Instead all materials are turned into valuable co-products, including the soil attached to the beet, which becomes clean soil for gardeners, these actions contribute to a very high level of efficient use of raw materials. The company has been able to bring more value under its control and link knowledge to benefit by turning everything into a valuable output.
Case C	**Collaboration-Co-ordination competency**	A Global reputed apparel company, through new collaborations with actors outside its sector and launching a garment collecting Initiative is able to produce close-loop products. The case company is observed to tackle the waste to landfill problem caused by the clothing industries fast-fashion model by partnering with a waste company outside its current value chain to produce closed loop products. Previously 10 to 15 years ago the recycling company was just a waste system, now it is observed the waste company is becoming part of the organisations production system. The company is observed to develop a more organised relationship with the waste company.
Case D	**Collaboration-Co-ordination**	A British retailer, with new collaboration and relationships with a charity organisation (unusual partner) was able to implement a model called “shwopping” (buy one, give one culture). The business model allows unwanted items to be resold, reused or recycled by a charity partner. This case study illustrates by collaborating and coordinating with unusual partners and expanding the system boundary, solutions to issues such as waste to landfill can start to be addressed.
Case E	**Whole system design competency**	A SME automobile company that aims to produce mobility at zero cost to the planet. The company offer a new business model and takes a systems view to create new forms of value. Sells mobility to driver and they pay for the fuel. This unlocks a new value system that allows them to build 250 mpg (e) cars. The organisation offers an innovative business

		model where the company sells mobility by charging customers a fee per month and per kilometer, the company then pay for the fuel. The case company offers an example of how it has found advantageous connections across the system and illustrates maturity in the whole systems design competency. The car company, by taking a systems view, internalised the fuel cost, the company pays for the fuel and customer the distance traveled. The company was able to look for win-win interactions. The company is found to be able to deliver the business model by focusing on the interaction where by making the car light, this then resulted in a lighter engine needed because it is a smaller car, then the brakes need was required to be less powerful, because the car was less heavy, then the requirement was you can put less fuel in it. The petrol tank gets smaller and lighter. If everything gets lighter, you can make the engine light because it needs to move less metal, this is an example of a win-win interaction. The system thinking literature suggests, you also need to check for the unintended consequences.

4.2 Competencies identified and proposed

By exploring what works and what does not work, the authors have observed competencies that are felt to be important for planning for transformation to sustainable industrial systems.

i. Efficiency competency:

It appears organisations are able to improve and manage efficiency by managing labour and capital, having many years of practice and training focusing on improving labour and capital productivity for example by (Lean, Just-In-Time) management practices. Organisations appear to be incredibly good at managing this. However, it appears most organisations have not yet learnt how to use that ability to find environmental and social waste and systematically reduce it. From Case A, the automobile company that was able to reduce their energy bill drastically and send zero waste to landfill. It is observed the company was able to achieve this by seeing waste better and using their expertise (the kaizen muscle) to systematically reduce their energy creatively. It is observed the efficiency

competency is the transformation of something most organsiations are already good at, onto a completely different focus. It appears the challenge is ability to seeing waste. It is found good organisations are able to see environmental and social waste, in away they have been able to traditionally see labour waste.
Efficiency competency skills observed:

- See environmental & social waste
- Able to reduce non-labour resource waste
- Creative in waste reduction
- Systematic in reducing waste

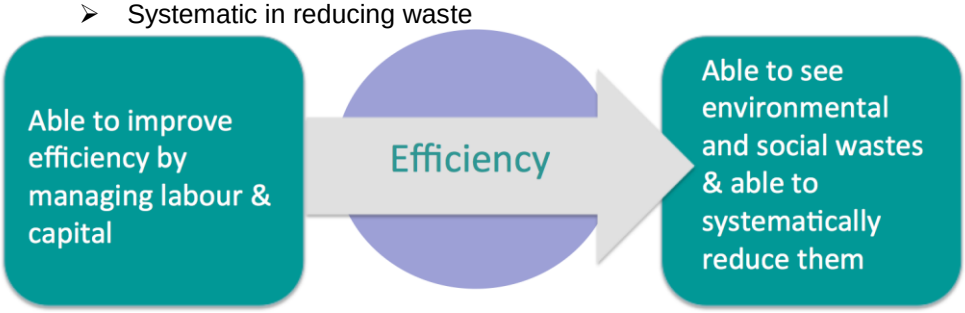

Figure 2. Efficiency competency

ii. Internalisation competency:
From Case study B, the FMCG company has been able to transform all raw materials into value and products by being effective in internaliastion. It appears oganisations are able to co-create value and develop new business models through the internalisation competency mechanism. Organisations are also able to bring more value under their control by linking knowledge to bring more variables into their control. The author identifies and proposes that internalisation competency can be used by oganisations to see opportunities for internalising costs and transforming them to co-create value and develop new business models.
Internalisation competency skills observed:

- Can see opportunities for internalising costs and transforming them to value
- Can co-create value
- Innovative in finding answers
- New business models

Figure 3. Internalisation competency

iii. Co-ordination and collaboration competency:

From the case study C & D the retail companies that have been seeking a solution for the fast fashion waste to landfill problem. It appears that these organisations by making the system boundary bigger have been able to find win-win interactions by bring more new variable into the system. The company is found to collaborate with unusual partners that are now becoming part of the organisations production system to finding innovative solutions to closing the material loop.It appears from the case study analysis, system-level innovation will not happen in the current value chain of an organisation, because organisations already explore all the different variables and have access to it already, i.e. the company already knows it's suppliers and the value chain. It is observed organisations that have been able to look for new variables, to find a new win-win interaction, in most cases, the variable is owned by an actor who is outside the industry i.e. who is an unusual partner. The author identifies and proposes the competency needed is, ability to co-ordinate and collaborate outside of the sector. It appears organisations need to be able to visit a lot of strangers (organisations with different expertise) and figure out which type of actors to bring into the system. Most organisations are today really good at managing their supply chains that is not the same as tight co-ordination with new types of collaborators.

Co-ordination and collaboration competency skills observed:

- Can collaborate with new organisations
- Can look for new partners

Figure 4. Coordination & collaboration competency

iv. Whole system design competency:

Case E is found to by taking a systems view to problem solving, and looking at the whole system and been successful in identifying useful interactions between the components. It is found the case companies approach to not practicing the normal problem solving technique, which is to break the problem to sub-problems and allocate it to subject experts. The holistic systems approach to problem solving has led to the company to develop a radically new innovative business model. Where the car manufacture now sells mobility to customer and the manufacturer pays for the fuel. This unlocks a new value system that allows them to build 250 mpg(e) cars. It appears from the current industrial systems, efficiently manufacturing products that are inefficient in use, for example, is not enough. This approach appears to result in substantially negative outcomes when efficiency gains or cost reductions result in increases in consumption. It is found from the case study analysis, instead of starting with a tough problem and reducing it to sub-problems and allocating it to subject experts which results in more incremental performance improvements. Organisations using whole system design approach is found by seeing the whole problem and looking for useful interactions between the components. From the case study analysis, it appears organisations that are comfortable in making the system boundary bigger and bring more variable into the system are able to find win-win interactions. The author proposes whole system design competency being important and effective in finding solutions to designing a sustainable future.

Whole system design competency skills observed:

- Able to set system boundary
- When you can not solve the problem is comfortable in making the boundary bigger
- Can find win-win interactions (positive feedback)
- Can search for unintended consequences

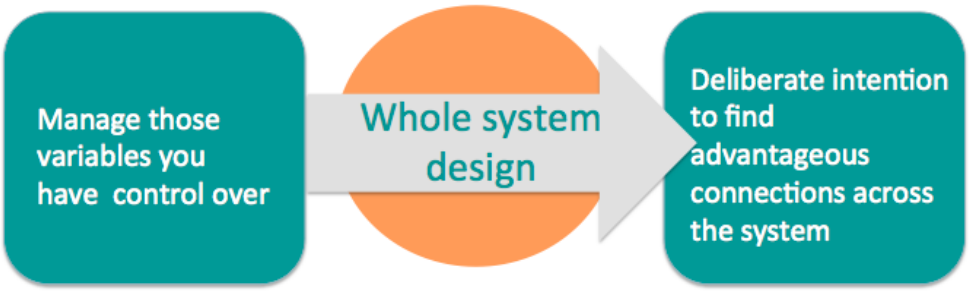

Figure 5. Whole system design competency

5. Future work and proposed competency assessment framework

One way of assessing organisational capabilities is by means of maturity grids (Clarkson, 2012). The four capabilities identified and observed that is discussed above, is mapped and developed into a competency assessment framework (Figure 6). The framework will be used in future studies to better understand the sub-factors and actions that enable transformation to sustainable industrial systems within the four competencies. The proposed framework is designed for industry actors to be able to map current state of the organisation against the 4 competencies, and design the future desired state and plan actions needed for transformation. The first stage in the frame 'becoming aware' refers to the organisations awareness of the competency and knowing what to focus on. The second stage 'becoming effective' refers to doing it right. The third stage refers to using the best technological practice. The fourth stage 'becoming effective' refers to having the ability and skill in the organisation to doing the right thing. The fifth stage 'transforming the performance of the system' refers to the ability to finding and implementing step-changes (transformative).

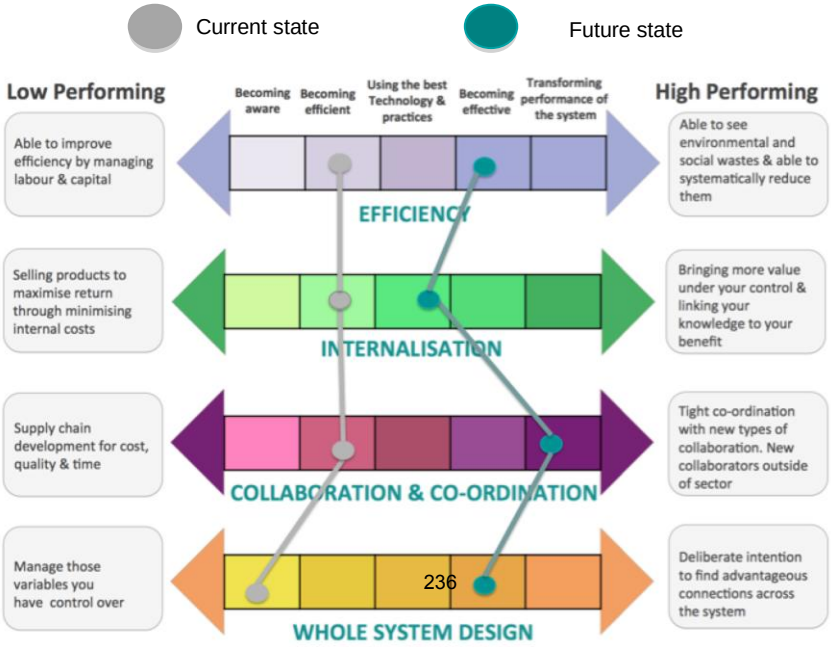

Figure 6.Competency assessment framework

6.0 Discussion

It is found current-planning techniques may not be adequate to help envisage and prepare for radically different sustainable futures. The focus of the research enquiry has been to better understand 'what are the key competencies necessary to plan for a sustainable future?' From the case study analysis key competencies for industry actors to transform to a more sustainable industrial system are identified. The cross sector case company analysis offers findings on what other organisations have done to improve sustainability performance by focusing efforts on developing key competencies. It is found that change is achieved through innovative thinking and careful planning. The challenge observed is organisations don't have a common language for talking about the system. It appears when organisations find ways of effectively deciding how their system works today; it is helpful in going onto design the future system. The key competencies 'efficiency', 'internalisation', 'collaboration and co-ordination' and 'whole system design' are identified in the case study analysis as being important. The competencies were observable from five cases of leading organisations.

The efficiency competency, it seems that leading organisations that are able to improve and manage efficiency by managing labour and capital, are able to use that competency to see environmental and social waste and able to systematically reduce waste. Case company A, by seeing waste better was able to use its expertise (the kaizen muscle) to systematically reduce their energy. It appears creativity in waste reduction is also important, as the case company was able to make the reduction with little additional investments. The company was able to see the waste and systemically reduce it by being clever.

The internalisation competency, analysis found that organisations are shifting their business models from selling products in order to maximise return and minimize internal cost to innovative business models. By implement concepts such as industrial ecology (waste equals food) through internalizing mechanism, the company appears to be able to create and extract more value. Case company B was able to convert all by-products into valuable output. However it was found that this competency was challenging for the other case organisations and not all were able to shift their understanding on how to internalise externalities.

From the case study C & D the retail companies that have been seeking a solution for the fast fashion waste to landfill problem. It appears the organisations by making the system boundary bigger have been able to find win-win interactions.

The company is found to collaborate with unusual partners that are now becoming part of the organisations production system has been able to find innovative solutions and business models to closing the loop. It appears organisations need to be able to visit a lot of strangers and figure out which type of actors to bring into the system. It was observed that the ability for a firm to widen its system boundary allows companies to address systemic issues that individual companies can't address on their own.

From the whole system competency analysis it was found that case study D was able to offer and create new forms of value to their customers by innovative business models and finding advantageous connections across the system. The company appears to have achieved this by taking a systems view to problem solving, and looked at the whole system and looked for useful interactions between the components. From the case study analysis, it appears organisations that are comfortable in making the system boundary bigger are able to find win-win interactions by brining more variable into the system. It is observed that extensive management effort has been focused on taking a systems view and identifying the best leverage point with win-win interaction in the planning process of developing the companies business model.

7. Conclusions

The case study findings provide insights into what is important to practitioners in planning for a sustainable & resilient future. It is found that current-planning techniques may not be adequate to help envisage and prepare for radically different sustainable futures. The challenge observed is organisations don't have a common language for talking about the system for future system level planning. The four competencies; 'efficiency', 'internalisation', 'collaboration and co-ordination' and 'whole system design' are identified from the case study analysis as key competencies necessary to plan for a sustainable future. It is found that organisations developing and focusing on the efficiency competency need to be able to see environmental and social waste and able to systematically reduce them. Organisations that focus on Internalisation competency need to be able to bring more value under their control by linking their knowledge to their benefit. Organisationations focusing of co-ordinating competency need to be able to collaborate with organisation outside of its sector. It is observed that leading organisations have been able to look for new variables, to find a new win-win interaction. Organisations focusing on whole system design need to be able to find advantageous connections across the system, and is comfortable in making the boundary bigger and is able to search for unintended consequences of its decisions.

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