

Assessment of empowerment via inclusion of people in product lifecycle processes

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Abstract

To address the issue of unbalanced development during a product's lifecycle, a change in the approach to product development processes is necessary. One way to achieve this is by development of the product that encourages the inclusion of people in the entire lifecycle. Inclusion is intended to influence societal empowerment via sharing of power among the people included in the lifecycle. This study proposes a framework for assessment of empowerment by the inclusion of people within a product lifecycle.

Keywords: *inclusivity in product lifecycles, product development, case study*

1. Introduction

The typical focus of product development processes is on the product and involves understanding current conditions and providing a solution mainly to increase the quality of life of people as users of the product. Ulrich et al. (2019), for instance, proposed a product development approach with the stages of planning, concept development, system-level design, testing and refinement and production ramp-up, which excludes the end-of-life of the product. Products, on the other hand, are the outcomes of production processes, and their lifecycles impact humanity, other living things, and nature throughout the lifecycle. The conditions involve information for understanding constraints, needs of the people and human and natural resources that spread across the entire lifecycle of the product and not just its use phase. To improve these conditions require expanding the focus from the product and its use-phase to all phases of the lifecycle of the product, keeping inclusion explicitly in mind. This expanded focus, on developing the entire lifecycle with the inclusion of people in all its phases can address the conditions of the entire lifecycle.

Inclusivity of people in the product lifecycle was proposed as a new paradigm as a result of the discussions that took place in the Inclusive Manufacturing Forum in 2018 (Roy et al., 2018). “*Inclusive manufacturing aims at empowering people, especially those who are spatially, temporally, physically, economically and culturally disadvantaged, to actively participate in the conception, creation, distribution, transaction, use, and retirement of products and systems.*” (Roy et al., 2018). It can be interpreted that inclusivity in manufacturing (which is taken as the entire lifecycle of the product with manufacturing at its centre-stage) can be promising to generate conditions for the disadvantaged people to empower themselves. The World Bank defined empowerment as “*the process of increasing the capacity of individuals or groups to make choices and to transform those choices into desired actions and outcomes.*” (Nielsen, 2012). Adopting empowerment in the product lifecycle development process can reduce imbalanced development, which can improve inclusive growth by reducing poverty, equity in education, improving the well-being of people, etc.

This change in approach to development processes can support collaboration among people and evolve this into an empowering socio-technical process. However, before such transition can be ushered in, metrics for measuring such improvements need to be in place. In order to address imbalanced development worldwide, the 'From Poverty to Empowerment' report ([McKinsey Global Institute, 2023](#)) proposed two measures for inclusive growth: financial empowerment and net zero emissions. However, as discussed in the literature ([Kleba et al., 2021](#); [Jespersen, 2011](#)), empowerment can have various measures based on a variety of contexts and approaches to defining dimensions of empowerment. There is no generally acceptable set of dimensions that constitute empowerment. As discussed in the definitions of empowerment ([Hur, 2006](#); [Conger et al., 1988](#)), empowerment of an individual is not a static activity; a person needs to take or participate in action to empower herself.

Our study, presented in this paper, proposes a framework for assessing the empowerment resulting from the inclusion of people in a product lifecycle. The framework is intended to help understand the reasons for, and subsequently address, imbalanced development. In this way, it is aimed at improving the development process with more balanced outcomes.

Section 2 reviews literature in order to identify the major concepts necessary for assessing empowerment and inclusivity. Section 3 outlines the methodology. Section 4 describes the framework and Section 5 presents an application of the framework. The final section discusses future work.

2. Background

This section reviews the concepts of inclusivity, power, and empowerment.

2.1. Inclusivity

The literature ([Aflatoony et al., 2022](#); [Clarkson et al., 2015](#); [Coda et al., 2003](#)) discusses inclusivity mainly according to the guidelines of inclusive design, design for all, or universal design. Inclusivity in design processes is limited to considering inclusion of people only as users, with accessibility and usability of products as the main focus. [Zallio et al. \(2022\)](#) proposed 'inclusive design canvas' for fulfilling people's needs for accessibility based on a comprehensive analysis of requirements (physical, sensory, cognitive) by targeting inclusion, diversity, and equity. Without encouraging people to empower themselves, supporting equity by providing accessibility via a product, service, or system cannot be a sustainable solution for changing the development processes from imbalanced to balanced. It is required to consider the resources of people as well as their needs, as in the case studies of inclusive manufacturing ([Kakodkar et al., 2017](#); [Saha et al., 2019](#)). In this way, people can be included in different phases of the lifecycle by creating a coalition among stakeholder groups to achieve a common goal. Such inclusions could positively influence empowerment.

As discussed in our previous work ([Yaldiz et al., 2023a](#); [2023b](#)), the assessment of inclusivity in lifecycles can be measured with the evaluation of the influencing factors (context and enablers) and aspects (diversity and lifecycle) of inclusion. The above approach to inclusivity assessment gives an indication of the extent to which people from diverse backgrounds are included in the various stages of a product lifecycle. The results from an analysis of the diversity of people that can be suitably included in a given context in the various phases of the product lifecycle could be used as the basis for creating coalitions among them by sharing power. Creation of coalition can be a balancing operation to change the impact of imbalanced situations ([Emerson, 1962](#)).

2.2. Power

[Dahl \(1957\)](#) defined power as a property of all kinds of social relations by emphasising that “A has power over B to the extent that he can get B to do something that B would not otherwise do.”. [Emerson \(1962\)](#) explains power in connection with the dependency of others in a power network. The dependence of a person is influenced by two factors: motivational investment and availability to participate in a common goal. [Conger et al. \(1988\)](#) consider “power as a function of the dependence and/or interdependence of actors”, and the type of power is based on the resources used by people to exercise power. [Avelino et al. \(2009\)](#) define the approach of mobilisation (constructive and deconstructive) of power based on the resources. They propose a broad understanding of resources of

power as persons, assets, materials and natural sources. Schmalz et al. (2018) groups the resources of power as structural, associational, institutional and societal. As emphasised by Avelino et al. (2011), “Resources in themselves are ‘power neutral’; they only become power-laden when they are mobilised by actors.” Therefore, exercising power by using the resources creates power relations among the actors.

Zolghadri et al. (2011) use the factors of dependency (proposed by Emerson, 1962) as supply and demand to select power-based suppliers. They group the power relations as “bargaining power within the supply chain (power assertion, power abdication, equal power and power presumption)” based on the relative power of actors and also from the “customer’s perspective (strong domination, domination, equilibrium, subordination, strong subordination)”. Avelino et al. (2011) group power relations based on the similarity between the mobilised resources and differences in the amount of power of people who participate in the power network. For example, if actor A has more power over actor B in mobilising similar resources in a balanced situation, this can create mutual dependency; however, in an imbalanced situation, it can be a one-sided dependency. Emerson (1962) explains the balanced situation as “the power of A over B is equal to, and based upon, the dependence of B upon A.” An imbalanced situation can result from the difference in the amount of power and dependency of the people. As discussed in the literature, to evaluate the power relation between the actors, it is required to know the amount of power for each actor and their dependencies on each other.

In order to compare the relative degree of power between two people, Dahl (1957) discusses the importance of evaluating the “sources (domain, base), means (instruments), amount or extent and range or scope”. As proposed by Dahl (1957), the amount of power is a conditional probability, which gives the result for A’s power over B concerning action C by using the means. The amount of power is “conjunction with the means and scope”. The scope determines the context for the identification of the resource of people. El-Ansary et al. (1972) propose a measurement model according to the power aspects: control, dependence, and source. Benton et al. (2005) adopt a survey-based approach to find the amount of power based on variables (satisfaction, performance-supplier, performance-manufacturer, performance supply chain) in buyer/seller relationships.

2.3. Empowerment

Various approaches to empowering people are proposed in literature. In management science, empowerment can be defined as the perceived power of a person over others at an organisational level (Füller et al., 2009). It can also be a process of increasing the self-efficacy of a person in an organisation by identifying and removing the factors that can cause powerlessness (Conger et al., 1988). Del Val et al. (2003) defined dimensions of empowerment as formal/informal character inclusion, direct/indirect collaboration and degree of influence during the decision-making process. Acar et al. (2016) describe customer empowerment as giving “a sense of control over the brand’s general offerings.”. In marketing, the approach to customer empowerment is providing a sense of control to customers (Cova et al., 2006; Wathieu et al., 2002). Customer empowerment is a process of improving access, understanding and sharing of information (Pries et al., 2006). The process, for instance, can be a competition for customers to participate and share their designs, which can be concluded with the production of their designs (Ogawa et al., 2006; Fuchs et al., 2011). Prentice et al. (2016) proposed three dimensions for customer empowerment: service choice, information attainment and impact, and used these to propose a customer psychological empowerment (CPE) scale. In environmental sciences, empowerment is a transformation process of a community that can ensure the sustainability of their development (Sianipar et al., 2012). Based on the approval of the EU directive, the “right to repair” aims to “empower consumers to make informed choices and play an active role in the ecological transition” (European Commission, 2019; Hernandez et al., 2020). In manufacturing, employee empowerment requires balancing operations in power relations among managers for collaboration (Gunasekaran et al., 2018). Using literature review as the basis, Dubey et al. (2015) defined the following as dimensions of empowerment: “real-time communication/execution systems, automated-guided vehicle systems, internal source, everyone’s involvement, cooperation, delegation of authority, mutual trust”.

Based on the above approaches to empowerment, it can be interpreted that empowerment is a process of giving power to people to include themselves in a particular action, such as choosing, learning, participating, etc. However, as a process, empowerment has factors (communication pattern, information flow, use of appropriate technology, etc.) that can impact the empowering outcomes.

3. Methodology

The approach to the creation of a framework for the assessment of empowerment in a product lifecycle started with the aim of operationalising the definition of Inclusive Manufacturing: “...a new paradigm concept, where all parts of the lifecycle of a manufactured product is made accessible to people from all strata of the society, so as to accelerate sustainable development and dignified well-being for all. Inclusive Manufacturing aims at empowering people, especially those who are spatially, temporally, physically, economically and culturally disadvantaged, to actively participate in the conception, creation, distribution, transaction, use, and retirement of products and systems.” (Roy et al., 2018). As emphasised in the definition, empowering people, including the diversity of people and considering all stages of the lifecycle are the influencing factors of inclusive manufacturing. In order to understand the influence of the above factors on the success factors (in this case, sustainable development and well-being), we analysed 83 distinct cases of inclusive manufacturing. Analyses of these cases, arising from diverse fields (management, psychology, marketing, engineering, design, education and sustainability) helped us understand a variety of processes, outcomes, and metrics for empowerment. We analysed the definitions of empowerment in terms of 'functions' and 'enablers'. Repetitions on similar activities (granting power, sharing power, increasing power, gaining control, etc.) in 'functions' led us to 'power' related literature. Based on an analysis of 37 papers on power (from areas of management, social science, political science and philosophy), we developed a framework for assessing empowerment that measures the impact of functions in lifecycle processes based on inclusivity of people and power relations.

4. Proposed framework

The framework proposed for the assessment of empowerment aims to provide means for addressing imbalanced situations in product lifecycle processes. The reasons for imbalanced development can be various; our approach to limiting the context starts with the definition of the lifecycle of a product. As proposed by Urakami et al. (2018), the product lifecycle has five phases: planning, development, production, utilisation and recirculation. We use these phases in our framework to define the context for empowerment assessment. Once the context is defined (e.g. the planning phase of the lifecycle), associated functions within this context (i.e. this phase) can be identified, and their impact on empowerment can be adjudged. Each function can be started with a stakeholder or a stakeholder group and completed by another. Therefore, the function has an impact on stakeholders, which can influence them to take action. As shown in Figure 1, Function 1 is started by Stakeholder A, and it has an impact on Stakeholder B. Function 2 is a response to Function 1 and impacts Stakeholder A.

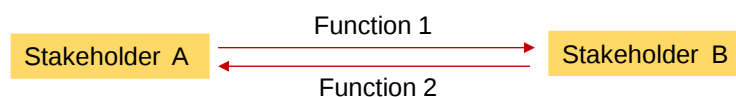


Figure 1. Function analysis between stakeholders

The empowering impact of a Function F_j , abbreviated $EI(F_j)$ on stakeholders depends on the number of included stakeholder groups (#stakeholders) and the number of tasks or functions (#functions) completed per person. The amount of impact can then be calculated using the proposed equation:

$$EI(F_j) = \text{\#stakeholders} \times \text{\#functions} \quad (1)$$

Zimmerman et al. (1995) pointed out that “...Actual power or control is not necessary for empowerment because in some context and for some populations real control or power may not be the desired goal. Rather, goals such as being more informed, more skilled, more healthy [sic.], or more involved in decision making may be the desired outcome.” (Hussain,2010). Therefore, the amount of impact of

empowerment alone cannot be sufficient to interpret the amount of power. However, measuring the amount of power is significant to address the reason for imbalanced development. The informative definition of power relations (see Section 2.3) should include extension and dependency levels. The extension is the potential of stakeholders to extend their scope to influence more stakeholders in the different stages of the lifecycle. Extension (Equation 2) is connected with the frequency of the stakeholder (the number of stages that a stakeholder has included herself/himself). It is impacted by the means (i.e., the number of tools used by stakeholders to complete the task).

$$\text{Extension} = \# \text{means} \times \text{frequency} \quad (2)$$

As discussed in Section 2.3, dependence on power relations has two aspects: motivation (demand) and availability (supply). The dependency level of stakeholders is also connected with the factors of dependence; in the context of a lifecycle, these are interpreted as need and resource respectively. The needs and resources of the stakeholders can be varied according to the functions. To standardise the types of needs and resources to be used, we adopted in our framework the matrix of needs and satisfiers proposed by [Max-Neef \(1992\)](#). Resources are the differentiation of the stakeholders from each other to share their belongings by fulfilling the needs of each other. For example, in Figure 1, what is the benefit of Stakeholder A for Stakeholder B by participating in function pairs 1 and 2? The answer is that Stakeholder A has a need that B can meet; therefore, Stakeholder B has sufficient resources for participating in the function, and this situation can be vice versa. The dependency level of stakeholders (Equation 3) is the number of resources per need.

$$\text{Dependency level} = \# \text{Resources} / \# \text{Needs} \quad (3)$$

The amount of power of Stakeholder A is connected with the extension and the dependency level of B because “The power of actor A over actor B is the amount of resistance on the part of B which can potentially be overcome by A.” ([Emerson, 1964](#)). Therefore, the equation for determining the amount of power of Stakeholder A is as follows.

$$\text{Power (A)} = \text{Extension (A)} \times \text{Dependency level (B)} \quad (4)$$

5. Case study

[Ogawa et al. \(2006\)](#) emphasise the advantage of creating a customer community with the example of 'Threadless', a fashion company that designs its products by collecting ideas from its online community. Asking for contributions from customers is an approach to include them in the product development process by empowering them by giving control of the brand's variables. To demonstrate the empowerment assessment framework, we elaborate on the product development process of Threadless as explained by [Ogawa et al. \(2006\)](#) and [Fuchs et al. \(2011\)](#). Due to the limited explanation of the process available in the above literature, our elaboration include an analysis of the functions involved in the lifecycle phases and determination of the stakeholders who involve themselves in these functions. We identified 88 functions which were included in the planning, product development and production stages. In Table 1, we limited the list to the first 34 functions only; these describe only the product planning stage. According to the explanations of these functions, the role of stakeholders in each function was defined as 'providers' and 'receivers'. Providers ensure resources or an opportunity to benefit from it for receivers. For instance, in Table 1, in function pairs 1 and 2, the manager provides an opportunity for the coordinator to empower himself. Receivers access this opportunity based on their resources and needs, and according to their capabilities and conditions, they can participate in the function pairs. We accepted internal stakeholders as manager, coordinator, and project, production and sales teams. We grouped the customers into the following: resource, co-creator, evaluator, buyer and user ([Nambisan 2002](#); [Urakami et al. 2018](#)) without considering the number of people in each group. In order to evaluate the power relation between any two groups, it is required to define the function pairs. Each function pair starts with asking for a contribution and ends with the contribution. We evaluated each function pair based on the amount of power and dependency level of their stakeholders (Table 1).

Table 1. Power and Empowerment Analysis

Function Pair	Function No (Fj)	Function Explanation	Stakeholder	Role	Lifecycle Stage	#Stakeholders	# Task per person	EI (Fj)	Means	Frequency	Extension	Groups of the needs	# Need groups	Groups of resources	# Resource groups	Dependency level	Power
F1&F2	F1	Assigning coordinator	Manager	Provider	Planning	2	1	2	1	3	3	Participation and Having	2	Position	1	0.5	1.5
	F2	Getting the task	Coordinator	Receiver	Planning	2	1	2	1	3	3	Participation and Having	2	Capability	1	0.5	1.5
X	F3	Change in role	Coordinator	Provider	Planning	1	1	1	x	x	x	X	X	X	X	X	X
	F4	Uploading the announcement	Coordinator	Provider	Planning	1	1	1	x	x	x	X	X	X	X	X	X
F5&F6	F5	Asking for contribution	Coordinator	Provider	Planning	2	1	2	1	3	3	Understanding and Interacting Participation and Doing	4	Capability	1	0	0
	F6	Getting know about the opportunity	Customer - Resource	Receiver	Planning	2	1	2	1	2	2	Understanding and Doing	2	X	0	0.25	0.5
X	F7	Change in role	Manager	Observer	Planning	1	1	1	X	X	X	X	X	X	X	X	X
	F8	Observing Coordinator - F4&F5	Manager	Observer	Planning	2	2	4	1	3	3	Participation and Having	2	Position	1	0.5	1.5
F8&F9	F9	Being observed by manager- F4&F5	Coordinator	Provider	Planning	2	2	4	1	3	3	Participation and Having	2	Position	1	0.5	1.5
	F10	Understanding personal performance boundaries	Customer - Resource	Receiver	Planning	1	1	1	X	X	X	X	X	X	X	X	X
X	F11	Decision-making on joining or not	Customer - Resource	Receiver	Planning	1	1	1	X	X	X	X	X	X	X	X	X
	X	Preparing design for printing on T-shirts	Customer - Resource	Receiver	Planning	1	1	1	X	X	X	X	X	X	X	X	X
X	F12	Change in role – Receiver to Provider	Customer - Resource	Receiver	Planning	2	1	2	X	X	X	X	X	X	X	X	X
	F13	Submitting designs	Customer - Co Creator	Provider	Planning	2	1	2	1	2	2	Creation and Doing	2	Capability	1	0.5	1
F14&F15	F14	Receiving designs	Coordinator	Receiver	Planning	2	1	2	1	3	3	Participation and Doing	2	Position	1	0.5	1.5
	F15	Change in the role – Provider to Receiver	Coordinator	Receiver	Planning	1	1	1	X	X	X	X	X	X	X	X	X
X	F16	Observing the Coordinator (F15)	Manager	Observer	Planning	2	1	2	1	3	3	Participation and Having	2	Position	1	0.5	1.5
	F17&F18	Being observed by Manager (F15)	Coordinator	Receiver	Planning	2	1	2	1	3	3	Participation and Having	2	Position	1	0.5	1.5
X	F18	Change in the role – Receiver to Provider	Coordinator	Provider	Planning	1	1	1	X	X	X	X	X	X	X	X	X
	F19	Uploading the info about how to vote	Coordinator	Provider	Planning	1	1	1	X	X	X	X	X	X	X	X	X
X	F20	Observing Coordinator (F20&23)	Manager	Observer	Planning	2	2	4	1	3	3	Participation and Having	2	Position	1	0.5	1.5
	F21	Being observed by Manager (F20&23)	Coordinator	Provider	Planning	2	2	4	1	3	3	Participation and Having	2	Position	1	0.5	1.5
F21&F22	F22	Asking for evaluation	Coordinator	Provider	Planning	2	1	2	1	3	3	Understanding and Interacting Participation and Doing	4	Position	1	0	0
	F23	Receiving the task	Customer - Evaluator	Receiver	Planning	2	1	2	1	2	2	Understanding and Doing	2	X	0	0.25	0.5
F23&F24	F24	Understanding the use/rules of the voting system	Customer - Evaluator	Receiver	Planning	1	1	1	X	X	X	X	X	X	X	X	X
	F25	Change in the role – Provider to Receiver	Customer - Evaluator	Receiver	Planning	2	1	2	X	X	X	X	X	X	X	X	X
X	F26	Evaluating designs	Customer - Evaluator	Receiver	Planning	1	1	1	X	X	X	X	X	X	X	X	X
	F27	Decision-making on the votes/numbering	Customer - Evaluator	Receiver	Planning	1	1	1	X	X	X	X	X	X	X	X	X
X	F28	Submitting Votes	Customer - Evaluator	Provider	Planning	2	1	2	1	2	2	Participation and Doing	2	Capability	1	0.5	1
	F29	Receiving the votes	Coordinator	Receiver	Planning	2	1	2	1	3	3	Participation and Doing	2	Position	1	0.5	1.5
F29&F30	F30	Change in the role – Receiver to Provider	Customer - Evaluator	Provider	Planning	1	1	1	X	X	X	X	X	X	X	X	X
	F31	Change in the role – Provider to Receiver	Coordinator	Receiver	Planning	1	1	1	X	X	X	X	X	X	X	X	X
X	F32	Observing Coordinator (F30)	Manager	Observer	Planning	2	1	2	1	3	3	Participation and Having	2	Position	1	0.5	1.5
	F33	Being observed by manager (F30)	Coordinator	Receiver	Planning	2	1	2	1	3	3	Participation and Having	2	Position	1	0.5	1.5
F33&F34	F34																

As shown in Table 1, all functions cannot create function pairs (i.e. one function can be completed by inclusion of only one stakeholder). For instance, functions 3 and 4 are individual tasks completed by the coordinator. These functions have empowering impacts on the coordinator. However, in similar one-function and one-stakeholder situations, the amount of power of the stakeholder cannot be measured because the stakeholder completes the function independently. In function pairs 5 and 6, we cannot determine the resource of one of the stakeholder groups (customer group as a resource). Therefore, we interpret that if the resource of a stakeholder in a function pair cannot be determined, that stakeholder is independent of the other stakeholders involved in that function pair. As in the function pair 14 and 15, the dependency levels of the stakeholders are equal due to the equality of the number of needs and resources. However, the amount of power of the stakeholders is different based on the difference in their frequencies. Therefore, in case of equality in dependency levels, increasing the frequency of the stakeholder can balance the amount of power of the stakeholders, as shown in Table 2. We cannot interpret the impact of means (i.e., the number of tools used to complete the function) on the amount of power of stakeholders because, in all functions, the number of means is the same.

As emphasised in Section 4, the amount of power is not always correlated with the impact of empowering; it can also be interpreted by comparing the empowering impact of functions and the amount of power (see Table 1). As shown in Table 2, we grouped the power relations as balanced and imbalanced based on our findings from Table 1 on the dependency levels, frequency of the stakeholders, the amount of power and empowering impact of functions on the stakeholders. In both balanced and imbalanced power relations, the empowering impact of the functions is bigger than the amount of power of stakeholders who participated in these functions.

Table 2. Power relation model

Imbalanced Power Relations	Balancing Operation
Power A > Power B Dependency B > Dependency A = 0 Frequency B > Frequency A $E_i > \text{Power}$	Determine resources of the stakeholder
Power A > Power B Dependency A = Dependency B Frequency A > Frequency B $E_i > \text{Power}$	Increase the frequency of the stakeholder
Balanced Power Relations	
Power A = Power B Dependency A = Dependency B Frequency A = Frequency B $E_i > \text{Power}$	-

From 88 functions, we identified 29 function pairs (only 9 of them are presented in Table 1 due to page limitation). As shown in Table 3, stakeholders created a coalition to achieve three different goals: collecting designs from customers (Coalition A), choosing the best design by customers' evaluation (Coalition B), and controlling the most voted designs' quality, appropriateness to the existing catalogue and legal consideration (Coalition C). Each coalition includes a different number of functions, and each stakeholder participates in different functions. In Coalition A, the coordinator participates in eight functions; in B, seven and in C, it is nine. The number of stakeholders in Coalition A is more than the number of stakeholders in B; the empowering impact of the functions on the coordinator is greater in A than in B. The number of stakeholders is equal in Coalitions B and C. However, the number of functions in Coalition C is bigger than in B, and the coordinator has a higher empowering impact of functions in Coalition C than in B. It is difficult to address the direct impact of the inclusion of people in the empowering process with the comparison of the empowering impact of functions on the coordinator in Coalition A and C. Because in Coalition A, the number of stakeholders is greater than in C, and the coordinator participated in more functions in C. Based on the analysis of coalitions, whenever the number of functions and stakeholders increases, the empowering impact and power increase; if only one

increases, the results can be ambiguous. It can be interpreted that including many people alone is not enough for empowerment, but their functions are also important.

Table 3. Coalition among the stakeholders

Coalition A (F1 - F18)		Total # of functions
Stakeholders	The sum of the empowering impact of functions from F1to F18	18
		#Functions the stakeholders participated in
Coordinator	15	8
Manager	9	3
Customer Resource	7	5
Customer Co-Creator	2	1
Coalition B (F19 - F34)		Total # of functions
Stakeholders	The sum of the empowering impact of functions from F19 to F34	16
		#Functions the stakeholders participated in
Coordinator	13	7
Manager	6	3
Customer Evaluator	10	7
Coalition C (F35 - F57)		Total # of functions
Stakeholders	The sum of the empowering impact of functions from F19 to F34	23
		#Functions the stakeholders participated in
Coordinator	17	9
Manager	20	11
Project Team	22	9

6. Discussion and conclusions

In order to reduce the development gap among societies, there is a need for shifting the emphasis of development from product to product-lifecycle and being inclusive in all phases of that lifecycle. Imbalanced power relations in lifecycle processes can impact the inclusion of people in the processes. Assessing the inclusivity of people in the lifecycle processes is the first step towards providing opportunities for people to participate in all the functions during the entire lifecycle. With this participation, people could empower themselves, which is an influence of inclusion.

In this study, we proposed a framework for understanding imbalanced situations in lifecycle processes. Our approach starts with analysing lifecycle functions and associated coalitions among the stakeholders. The understanding of each function is used to clarify the needs and resources of the stakeholders who participate in that function. The empowering impact of the function is correlated with the number of stakeholders who participated in the function and their tasks. Understanding the needs and resources of the stakeholders is important to the inclusion of people in a function. The division of the resources per needs can find the dependency level of the stakeholders. Adopting standardisation is required to determine the need to understand power relations based on dependency levels. However, in addition to the dependency level, the amount of power is influenced by the means (the number of used tools) and frequency of the stakeholders based on their inclusion in the phases of the lifecycle. The resources of people can be used in the different stages of the lifecycle by inclusion of them. This can increase the frequency, which can balance the amount of power of stakeholders, as discussed in the case study.

We applied the proposed framework to a case of inclusive manufacturing. The lifecycle processes narrated in the case are analysed to assess the inclusivity of people in these processes (i.e., in their functions), their empowerment and their power. In this case study, the empowering impact of functions on stakeholders is found to be higher than the amount of power exercised by the stakeholders. As emphasised in Section 5, a minimum inclusion of two stakeholders is required to exercise power. Therefore, we can interpret that some functions include only one stakeholder. However, more research is needed to understand the relationships among inclusivity, power and empowerment. Further work is also necessary to address empowerment via inclusion. All of these are, therefore, part of our future work.

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