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Tech Tides: Steering Through Cooperative Complexities with the Institutional Role Model as an Economic System Architecture

Henrik Kleis

Chair of Mobility, Trade & Logistics, Zeppelin University, Friedrichshafen 88045, Germany

Corresponding Author Email: henrik.kleis@zu.de

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ABSTRACT

The Institutional Role Model (IRM) is a versatile tool used as an economic system architecture in various projects, such as the Gaia-X 4 Future Mobility lighthouse project family. This paper examines the effects of digitalization and geo-economic changes on cooperative instruments and demonstrates how the IRM can be optimized to meet these new requirements. The proposed optimizations include implementing the roles of Chief Innovation Officer, Sustainability Manager, AI Manager, and Remote Work Manager. Furthermore, a new prioritization according to Very Important Roles, Essential Roles, and Supporting Roles was integrated into the model. Furthermore, artificial intelligence was anchored in the dimensions as a complementary perspective and role-taking institution. The result is an updated matrix, offering an up-to-date and adaptable tool for managing complex environments. Based on these changes, the institutional role model can continue to create a cooperative environment in complex digital projects in the future and thus realize the added value of cooperation as a steering instrument.

1. INTRODUCTION

There are many examples of ambitious technological projects without economic success. Be it the Concorde supersonic aircraft [1], the Google Glass augmented reality glasses [2], or the Windows Phone operating system [3], successfully developed technology alone is not enough for long-term economic added value. This is because, for several reasons, none of these efforts succeeded in transferring the developed technology into a socio-economic environment and thus positioning it competitively on the market in the long term [4-8]. The challenges in projects with a digital focus are increasing [9, 10], increasing the likelihood of unsuccessful market implementation.

This is where the instrument of the Institutional Role Model comes in, which offers the opportunity to consider and incorporate both technical and economic perspectives in the development process of innovative technologies before market launch. In addition to this harmonization of technical and economic tasks (= roles), the Institutional Role Model (IRM) contributes to the reduction of complexity in such market entry efforts, as it is used to assign particularly suitable institutions to the various roles identified, thus not only optimizing transaction costs but also increasing transparency and trust among project participants [11, 12]. The importance of IRM is based on its controlling quality, clarity, completeness of responsibilities, and linking technical functionality with economic marketability. As explained in the course of this work, the level of competence concerning innovation projects is no longer high enough among individual players, which is why strategic alliances are required which increase the cooperation effort and thus the transaction costs. If cooperation projects are abandoned, there is a risk of reduced competitiveness due to the changed market environment, which is why using a coordinating and controlling instrument such as the IRM is necessary to make cooperation projects successful. For this reason, IRM has been and is being used as an economic system architecture in various complex digital projects, such as in the current Gaia-X lighthouse project family 4 Future Mobility [13], in which digital identities for the mobility sector are being developed [14].

The challenges of large-scale digital projects are reflected in new requirements for steering instruments, such as the institutional role model. Shorter product life cycles in dynamic markets [15] and agile working, for example, in software development [16], create a need to quickly determine and update the knowledge gained in the IRM process. In addition to these temporal effects, there are technological developments, such as using large language models as an optimization tool [17], which could take on roles as an institution in the sense of IRM. Roles have also changed in the course of digitalization. New roles with changing prioritizations have emerged [18], which in turn should be reflected in the development process of the IRM.

The research question of this paper is: What adjustments can be made to the four dimensions of the IRM to meet the new requirements of collaborative projects? The aim is to develop at least one suggestion for improvement for each of the four dimensions and then to create an updated IRM matrix.

Chapter two begins by examining and presenting the latest

requirements for cooperation resulting from digitalization and changing geo-economic situations and the significance of these for cooperative instruments such as the institutional role model. The IRM is introduced in Chapter 3 and explained using its four dimensions and the 5-step process. Building on this, Chapter 4 then updates the four dimensions and the 5-step process of IRM, and Chapter 5 presents an optimized IRM example matrix. The insights gained are then summarized in the conclusion, including a brief outlook.

2. NEW REQUIREMENTS FOR COOPERATION

2.1 The geo-economic relevance of cooperation projects

The megatrends of globalization and digitalization are placing new demands on companies' competitive conditions. All companies must adapt to these so they do not lose competitiveness and fail in their entrepreneurial transformation. The megatrend of globalization means that global corporate relationships are becoming increasingly interdependent, and the megatrend of digitalization means that companies' connectivity is increasing in various ways and instantaneously [19]. In recent decades, global supply chains have become increasingly intertwined, and ever faster and broader accessibility of all goods has been successively achieved, with this accelerating dynamic continuing. At the same time, the global spread of digital interfaces for process control and process optimization of the worldwide flow of goods has also increased the demand for expertise in dealing with enormous connectivity [20]. In addition, both megatrends are mutually accelerating due to the intertwining of interdependency requirements and connectivity requirements, which further cements their geo-economic scope and relevance. It can, therefore, be assumed that those companies that do not find adequate answers to the requirements of both megatrends will not be able to survive in the competitive environment of the global economy of the 21st century in the medium and long term. It is, therefore, essential for every company in every sector to take targeted measures. In this context, corporate cooperation plays a vital role because different competencies are merged due to this cooperation. These should complement each other to jointly generate entrepreneurial added value that no company partner would have been able to achieve on its own. These corporate collaborations are becoming increasingly relevant because the complexity of the goods to be produced and services to be provided has generally increased due to the rise in globalization-induced interdependency requirements and digitalization-induced connectivity requirements. Therefore, instead of just engaging in competition, seeking cooperation to increase innovativeness might be a successful approach [21]. This makes it increasingly unlikely that individual companies can develop comprehensive expertise about all the roles to be performed. For this reason, science is also called upon to conduct supporting research into how cooperation projects can be carried out that meet the complexity requirements of the 21st century and in which each company partner is willing to participate because they can recognize a clear added value in participating in the cooperation project. It is, therefore, important that the institutional role model, which represents a strategic coordination tool for corporate cooperation, is revised in its theoretical foundation to reflect the latest interdependency-related and connectivity-related effects of the megatrends of globalization and digitalization. It can then represent an optimized strategic coordination instrument for cooperation projects in the geo-economic competitive environment of the 21st century. Furthermore, it can be argued that such a complexity-adequate strategic cooperation instrument is an increasingly indispensable prerequisite for far-reaching entrepreneurial ambitions in the globalized and digitalized competitive environment. This is because, as described above, it is becoming increasingly unlikely that individual companies will have all the skills required to perform the necessary roles. Containerization is an important example of how the dynamics of globalization affect the initial conditions of cooperation projects. This is because the worldwide circulation of physical goods induced by globalization has made it possible to standardize container sizes, which has successfully reduced the price of transporting goods [22]. The Internet, on the other side, is an important example of how the dynamics of digitalization have improved the efficiency of virtual information exchange in international cooperation projects. The emergence and spread of the internet has led to the global exchange of virtual information in real-time, which has significantly increased the efficiency of inter-organizational information exchange [23]. Nowadays, letters no longer have to be sent, or people have to travel all the time; instead, e-mails are sent, and video conferences are held. Globalization and digitalization have, therefore, had an immense impact on physical and virtual goods in the form of containerization and internet technologies, which has significantly reduced the transaction costs for the implementation of cooperation projects in manifold ways.

2.2 The co-opetition relationships in cooperation projects

The concept of co-opetition describes a situation characterized by the simultaneous existence of a competitive and cooperative situation. It, therefore, involves at least two actors who compete and cooperate in their interests and actions because they expect to benefit from cooperation beyond the competitive situation, which gives rise to the state of co-opetition [24]. Certainly, many cooperation projects involve fundamental co-opetition relationships. It is, therefore, essential that the actors' trust in the achievability of the common objective is strengthened and that care is taken to ensure that all actors mutually adhere to the pursuit of the common objective in their actions and consequently contribute to the joint success. Co-petition is impossible without tensions [25]. At this point, it is also essential to bear in mind that establishing trust and confidence in the integrity of the actions of others in relation to an existing co-opetition relationship is a highly complex matter in which it is unlikely that the actors will be able to generate the necessary trust themselves and maintain it over time without external support. At the same time, it will become increasingly essential for companies from a wide range of industries to engage in such co-opetition relationships in the future to jointly increase their competitiveness and hold their own against the competition in the international markets of the 21st century. Consequently, co-opetition relationships represent simultaneously a significant challenge with a high level of risk and an indispensable component for maintaining and expanding competitiveness in the 21st century. In this area of tension, an innovative company must orient itself and try things out. The following optimizations of the theory of the IRM make it plausible how the trust of the cooperation partners can be

strengthened, thereby mitigating the fundamental complication of potentially existing co-opetition relationships on the part of the cooperation partners involved. However, it must be borne in mind that the risks of co-opetition relationships cannot be eliminated entirely but significantly reduced as the companies compete, particularly in other economic respects. It is clear that co-opetition will remain a highly complex problem that needs to be tackled [26]. The IRM represents a pioneering approach to solving the problem of co-opetition. It is a coordination tool ensuring that all institutions involved in a cooperation project pursue a common objective despite competition. This is because the IRM makes the joint added value of cooperation project participation visible by providing clarity about the roles to be performed and the efforts to be made. In this way, the IRM makes it possible to mitigate the problem of co-opetition.

3. METHOD – INSTITUTIONAL ROLE MODEL

"Too many cooks spoil the broth" - an internationally valid saying in various forms, which describes the general effect that an increasing number of (project) participants can have a negative impact on project work and the project result. This can have a variety of causes. For example, the productivity of individual project participants decreases as the number of participants increases - also known as the Ringelmann effect [27]. In addition, as the number of stakeholders increases, so does the number of individual interests, which increases the risk of a clash of interests within a project. These conflicts of interest lead to post-contractual opportunism between the partners - a so-called moral hazard [28]. Another challenge posed by complex projects is decreasing transparency. This is because the greater the number of players and associated tasks, the less clarity there is within a project, which negatively impacts perceived transparency. Low transparency is considered detrimental to building trust between the stakeholders [29], which can negatively impact collaboration and the project's success [30].

It is, therefore, crucial for the project's success to identify the correct number of suitable stakeholders to bring together all the skills required to achieve the goal. Furthermore, preferences must be harmonized, which implies that individual interests are aligned in such a way that they support the common goal and thus reduce moral hazard. In addition, the project stakeholders should trust each other to facilitate constructive cooperation. With its five-step process and the correlation of four different dimensions, the IRM offers a tool to counter these challenges and ensure project success. As explained in the following chapters, the IRM can be used to identify the actors and tasks required to achieve the objectives of a project or process and to manage them in terms of task suitability. The additional principle of anonymity during the identification and evaluation step makes it possible to reduce the moral hazard just described, as honest rather than strategic voting behavior is to be expected in the respective anonymous evaluation. The IRM also contributes to the transparency of processes and projects through a straightforward procedure, including all relevant stakeholders and a clear visualization at the end of the IRM process, as the full complexity of a project or process is thus presented visually in a simple manner. Combined with step five of a legal agreement presented in Chapter 3.2, these points ensure increased stakeholder trust [12].

To explain the IRM approach, a brief introduction to the process of creating an IRM and an explanation of the four dimensions will now follow.

3.1 The four dimensions

The IRM relates four dimensions to each other to promote cooperation in a complex environment. In line with the instrument's name, the dimensions of institutions and roles are explained first.

The term institution can be understood as a superordinate term in the sense of the theory of institutional role models and subsumes organizations (action systems) and regulations (regulatory systems) [31]. Institutions are, therefore, for example, associations, courts, authorities, companies, scientific institutions, or other organizations [12] and communities of interest, which have their own decision-making duties and rights and serve the purpose of controlling actions and communication between individual units based on defined rules [32]. It should be emphasized that there is no numerical limit to the number of institutions to be recorded and analyzed in the IRM. Still, the complexity of the model increases as the number of institutions increases. It is therefore necessary to identify the institutions critical to success using empirically adequate and methodologically precise procedures [33]. A proposal for such an approach is presented in the course of this paper. It is important to emphasize that an institution becomes an actor when it assumes a role in terms of IRM [11, 32].

Actions define roles. Actions are assigned to a specific role in a structured manner according to the consistency criterion. Characteristics of actions are

- Complementarity and neutrality of actions. Follow-up actions must not conflict with the original action [31].
- Conflict-free actions. Actions must always be consistent with each other [12].
- Measurability of actions. The contribution of actions to the fulfillment of objectives (effectiveness) can be measured [31].
- Concentration of actions. Actors can combine and carry out specific actions [31].

New roles can be defined and introduced if they are disproportionately essential or complex and cannot be performed sufficiently by a single actor. This breaks down the roles more finely so they can be better distributed among different actors.

The third dimension - the temporal dimension - is determined flexibly and on a project- or process-specific basis and is illustrated in Figures 1 and 2 as market phases (development, growth, maturity, stagnation). It must be adapted to the respective model and, analogous to the roles, can be broken down more finely into several phases [12]. This dimension can be found in figures one and two on the top page.

The fourth dimension is the operational dimension. This can contain action intensity (e.g., low, medium, high) or a neutral assessment through a 360° perspective (e.g., own, partner, neutral assessment). In Figures 1 and 2, the Operational dimension can be recognized on the right-hand side [12, 31].

As can be seen in Figure 1, the interaction of all four dimensions enables the harmonization of tasks, institutions and their suitability, the temporal component, and various internal and external perspectives. In this way, as explained in the previous chapter, trust can be built among the actors, and cooperation between them can be strengthened.

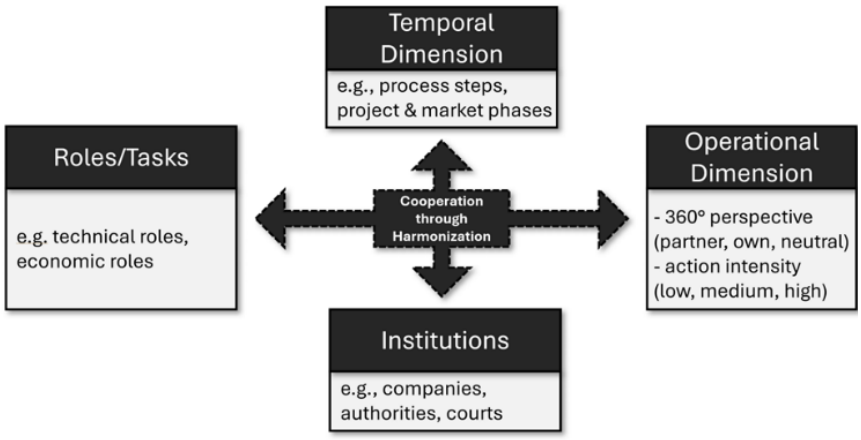

Figure 1. The four dimensions of the IRM
Source: own illustration based on [12, 32, 33]

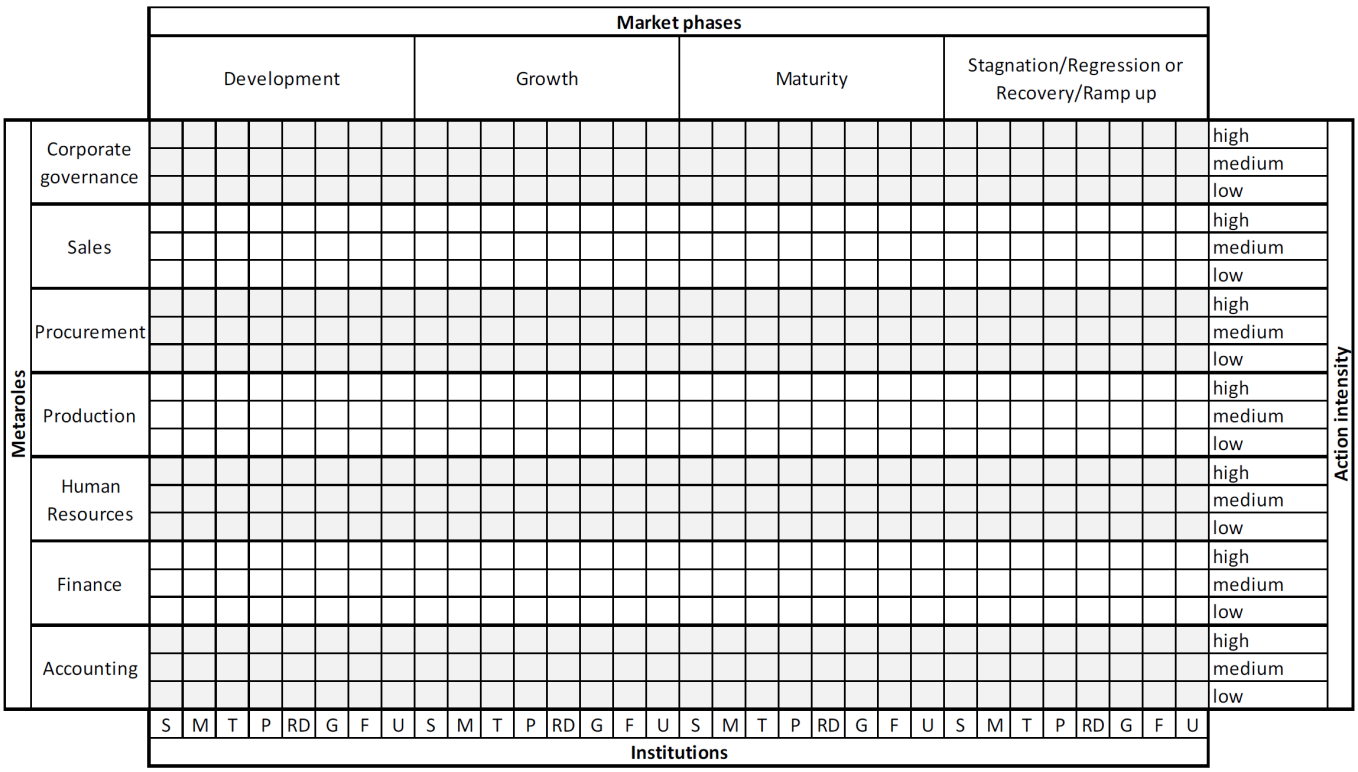

Figure 2. Classic IRM-Matrix [31]

3.2 The five-step process

The IRM consists of three core elements: rules, actors, and roles and functions. The following describes how the IRM matrix can be developed using five steps. The entire subchapter refers to [12].

Step 1: Identification and definition of meta-roles

After analyzing the objectives, specific actions are identified and analyzed in advance. Objectives must be measurable and operationalizable. The identified actions are then evaluated and categorized based on their contribution to achieving the objective. They are applied to the projects in question and then summarized into roles. Roles can be combined into so-called meta-roles if they complement each other. Even if roles contradict each other, this may require a separate meta-role. As can be seen in Figure 2, examples of economic roles are purchasing, sales, finance, accounting, and human resources. Technical roles could be software development, network provider, or IT support.

Step 2: Identifying and naming the institutions

As already explained, the possible forms of institutions that fall under the above definition are selected in any number and adapted to the project. This selection should satisfy methodological principles. Care should be taken to ensure that all the institutions required to achieve the objectives are identified to fulfill all the goals and roles defined in Step 1. One possibility for this is the qualitative data analysis of several expert interviews. Examples of institutions are authorities, courts, companies, or research institutions. Within a company, however, different departments can also represent an institution.

Step 3: Determining the suitability of the role assumption

The coding on which the IRM matrix is based can also be adapted flexibly and specifically to the project. The following

can be given as an example:

5 = The role should be taken on due to a unique selling point of the institution

4 = The role should be taken on by the institution as there is already experience in performing the role

3 = The role could be taken on, but so far, there is only a limited amount of experience in performing the role

2 = The role could be taken on, but there is no experience in performing the role to date

1 = The role should not be taken on

Participating institutions and experts evaluate the assignment of roles. As explained in Figures 1 and 2, this evaluation can be extended by a neutral individual or broken down in terms of their intensity of action. An algorithm evaluates various indices, such as a harmony or contribution index. The evaluation is anonymous so that any desired answers do not influence the voting behavior of the interviewees, and the greatest possible honesty can be achieved within the answers. Respondents, therefore, do not need to expect any repression after the evaluation. The scale can also be extended to include the option of not voting (e.g. 99 = no response). This makes it possible to calculate a contribution index, which can be used to show the proportion of assessments made per institution.

Step 4: Negotiations for final role allocation between the institutions

The coordination task resulting from the multiple allocation of individual roles is processed in this step. The role assumption negotiations can be held as a workshop in which a representative of each interested institution is invited. This deliberately includes the institutions identified as particularly suitable and all those interested in participating. During the workshop, the institutions commit themselves to taking on the various roles identified, whereby care should be taken to ensure that not only the most popular roles are taken on and less popular roles remain unfilled. Depending on the situation, various regulations or incentives can be created for this. An internal role hierarchy can also be agreed, so that there are role managers and role performers, for example. The developer of the role model should play a moderating role in this step.

Step 5: Agreement of a binding legal framework between the institutions

This step is essential if the entire construct is to be legally binding. A binding framework can be imposed on the IRM if desired. For example, contractual regulations can be created for the non-fulfillment of roles and, if necessary, extended to include sanctioning elements. Rules for the entry or exit of institutions can also be implemented. For example, rules can be agreed on the obligation to notify the institution of a wish to leave and successor regulations. At consortium level, it can also be part of step five to identify and agree on suitable company forms [11, 12, 31, 33].

3.3 The IRM-Matrix

Figure 2 shows an example of a traditional IRM matrix in one of its possible forms. The dimensions are arranged analogously to Figure 1. The roles dimension is on the left, the institutions dimension is on the bottom, the temporal dimension is at the top, and the operational dimension is on the right. All dimensions are granulated and categorized according to their respective logic. Roles have been grouped into meta-roles, and the respective institutions appear once per market phase. In this case, the operational dimension contains a subdivision into action intensity but can also include a 360° perspective with own, partner, and neutral evaluation, as shown in Figure 1. Schulz and Franck [11] also describe the possibility of classifying the institutions according to their sponsorship.

4. UPDATING THE FOUR DIMENSIONS

This chapter aims to scrutinize and further develop the existing dimensions of the IRM based on the findings of the previous chapters. The following chapter expands the dimensions of roles and institutions to include new roles and supplementary prioritization. In addition, a new possibility of institutional categorization is proposed, and a new fixed institution is integrated. Concerning the operational and temporal dimension, an extension of the 360° perspective, dynamic market phases, and forward-looking analytics are recommended. Building on this, additional considerations are formulated in section 4.3.

4.1 Dimensions of roles and institutions

The digital transformation, the associated acceleration of processes and workflows, and the enabling of disruptive business models increase the relevance of a current innovation strategy [34]. For role models at the company or consortium level, introducing a Chief Innovation Officer role, which deals with the empowerment of innovation-enhancing processes, is recommended. Specific tasks of the CIO would be to develop an innovation strategy and to observe competitors and their approaches. He creates an understanding at the management level of the urgency of constantly reviewing and developing the company's own business model and creates a culture of generating and sharing ideas at the employee level. Disruptive business models that could make the company's own model obsolete are thus recognized at an early stage and, if necessary, implemented by the company itself. Another effect of digitalization is the possibility of remote working. To prevent possible declines in productivity and declining employee satisfaction [35], the introduction of a remote work specialist role is proposed, which should contribute to the support and optimization of remote work and hybrid working models. The specific tasks of this role relate to enabling employees to work remotely efficiently. A suitable software solution for the company is identified and determined by the Remote Work Specialist. Furthermore, this role ensures a balanced and situation-specific relationship between remote work and physical presence. Checking and defining the equipment required for efficient remote working is also one of the tasks of this role. In times in which over 30% of companies across all industries already use artificial intelligence for standard business processes [36] and, according to another study in 2023, over 50% of the companies surveyed used AI in at least one function [37], the importance of an AI specialist role is also evident. This role should deal with current developments in digital intelligence and their possible use in the company or process to be analyzed. The rapid developments in artificial intelligence have created the need for this role. Therefore, the AI specialist's specific tasks are to monitor technological developments and check the possibility of their use, as well as to create an understanding of the technology's necessity among those involved. The AI specialist also deals with enabling the efficient use of AI. He defines suitable further education

measures and training for the stakeholders so that they can use AI as a tool to create added value.

Within the theory of institutional role models, the literature has so far only referred to economic or technical roles [11, 12, 31-33]. An ecological role category is recommended to enable sustainable management and meet regulatory requirements such as Corporate Sustainability Reporting [38]. This includes all roles that, for example, design sustainability strategies, consider and implement changes in legislation, design environmental management programs, or prepare sustainability reports. Furthermore, it could be part of these roles to draft internal codes of conduct to implement environmentally conscious behavior within the company and towards partners. This category complements technological and economic roles and moves the increasingly important focus of ecological management further into the center of IRM. This enables competitive advantages to be achieved [39]. In addition, unnecessary expenditure on penalties and transaction costs concerning regulatory institutions such as authorities can be avoided or reduced.

An additional prioritization of roles is also recommended. Based on this, a distinction can be made between Very Important Roles (VIR), Essential Roles (ER), and Supporting Roles (SR). Part of the VIR are roles that are decisive for the long-term success of the project or process. They include strategic decisions such as vision and innovation. If these roles are not taken on, the defined goal of the IRM is directly jeopardized, which is why an alternative role taker must be identified immediately. Institutions in these roles significantly influence business decisions and usually have the authority to issue directives. The second proposed prioritization, Essential Roles, contains roles that ensure the business or process's day-to-day functioning and operational excellence. These roles support the implementation and core processes of the strategic objectives. The third prioritization is Supporting Roles, which contain roles that support the VIR and ER in their work. They ensure that the necessary resources are available and take on functions required for the company's or projects' smooth functioning. SRs complement the VIRs and ERs and strengthen the overall system. If the new roles just introduced are categorized in this system, the Chief Innovation Officer would be part of the VIR, the AI specialist part of the ER, and the Remote Work Specialist part of the SR. It should be noted that the proposed prioritization has the same flexible character as the rest of the IRM structure. It can, therefore, be adapted to the specific process or project. Given the increasing complexity in the implementation of cooperation projects, the prioritization of roles to be executed is becoming increasingly important because it simplifies the essential components of the system architecture. Prioritizing roles can also have a positive effect on the allocation of resources. This allows resources to be focused on critical tasks, minimizing the risk of wasting limited resources on less important tasks while central tasks are not adequately supported. Prioritizing roles also helps to better manage potential risks. If it is revealed which roles directly jeopardize the common goal if they are not fulfilled, measures can be taken at an early stage to ensure that these roles are always supported and filled. Prioritization can also contribute to quality assurance. By clearly identifying the VIR, critical aspects can receive the necessary attention and be tested and validated accordingly. If new market conditions arise, the roles can be reprioritized flexibly on the basis of the original prioritization without changing the overarching goal. The separation between SR and ER ensures that supporting roles are designed in such a way that they can also work towards the ER in the long term, which can lead to an evolution and continuous improvement of the project. For these agility-promoting reasons, such prioritization is also used in the software development environment [40].

In line with the considerations in the previous chapters, in particular the recommendations for action for roles, it is recommended that artificial intelligence be included as a permanent institution in the role model. This does not have to be a special AI, but it should be an integral part of any IRM structure to question whether one or more artificial intelligence could take on roles. Given the state of development of large language models such as the open-source model Llama 3.1 [41] or the multimodal model GPT4o from OpenAI [42] compared to the first versions of these models, it is evident that artificial intelligence will be able to take on more and more tasks and thus roles in the future, such as routine tasks and decision-making processes. Current studies on the use of AI in organizations, which is steadily increasing in frequency and variation of use, come to a similar conclusion [37, 43]. In projects with a strong digital focus and the resulting software development, the use of AI can accelerate developers by up to 50% [44] and generally increase productivity, quality, and creativity within the development process [45]. Based on these developments, it can be concluded that the importance of artificial intelligence will continue to increase and will have a firm place in the future collaborative working world. It should, therefore, also be anchored in IRM. The implications of integrating artificial intelligence in the institutional dimension are wide-ranging. AI is becoming ever smarter, and its use is more diverse [46], while the costs of training the respective models are falling [47]. By taking over repetitive and easy-to-perform tasks, capacity can be created for more complex and creatively demanding core tasks. The challenges of using institutional AI lie, among other things, in the balanced use of this tool. Its use should not result in the displacement of humans through a pure AI fixation, but rather artificial intelligence should be a complementary and relieving tool in the sense of IRM. Future research must also determine the extent to which AI is truly creative and capable of taking on a wide range of roles in the future [48].

The second recommendation for expanding the institutional dimension is to differentiate according to geographical origin and the specialist area of the respective institution and to include this in the matrix if this makes sense for the specific situation. This way, a geographical balance can be established where necessary, and cross-border cooperation can be strengthened. However, differentiation by origin can also be made within national borders or an organization. An additional differentiation according to specialist areas and sectors can also identify possible gaps in expertise. In this way, in step two of the five-step process from Chapter 3.2, the identification of relevant institutions can be visually underpinned and verified.

4.2 Operational and temporal dimension

The temporal dimension takes on new significance in developing highly innovative products. In software development, for example, work is often done in short sprints using various tools such as SCRUM [49]. Shorter product life cycles and high innovation pressure require approaches such as the 'test-and-adapt' strategy or the rapid restructuring of different process phases [50].

Therefore, the author of this paper recommends using software development life cycle steps (planning, defining, designing, building, testing, deployment) as a temporal dimension in addition to process or project phases [51]. However, the temporal dimension should also be aligned with methods such as design thinking [52], agile software development, or SCRUM to do justice to the digital acceleration described in chapter two.

Another perspective should supplement the current 360° perspective of IRM. Artificial intelligence could be used to make data-based statements about emerging patterns and trends [53]. Based on historical data sets, an AI could be trained to carry out role evaluations to compare this with human-made evaluations. Furthermore, such an adapted AI could predict role suitability and identify risky institutions. Predictive analytics could identify risky institutions, such as those that cannot fulfill their role despite a high rating or do not fulfill their role to the defined end based on historical experience [54, 55]. This perspective supported by an AI can validate and expand the neutral perspective of an external expert or, in case of doubt, even replace it. At the same time, using AI in the operational dimension offers the possibility of developing role models without using people in a short period. For an initial analysis, identifying institutions and roles would be sufficient, and then letting the AI make statements about the respective suitability. Such a forward-looking analysis would be significantly less time-consuming than interviewing individual experts. Another option would be to inform such a trained A.I. of the jointly defined goal of the IRM so that it can then suggest roles and suitable and possibly missing institutions based on historical data. In existing role models, AI could be used in the operational dimension to monitor ongoing changes, gain insights, and, if necessary, issue early warnings, thereby facilitating and accelerating decision-making processes [56]. There are also some challenges when using AI in the operational dimension. First, a technically suitable model must be identified and selected. This model will require a certain amount of fine tuning in order to individualize it for the intended use. This requires a data set of sufficient quantity and quality [57]. Finally, when using artificial intelligence, care should also be taken to ensure that it can make mistakes. Possible hallucination, such as with LLM, the generation of repetitive results and various result biases should be taken into account [58].

4.3 Additional considerations

This chapter proposes additional considerations regarding further developing the IRM independent of dimensions. Focus groups are recommended as a suitable instrument for data collection regarding the five-step process and identifying roles and institutions. Focus groups are ideal for generating much information quickly compared to other methods. Participants are encouraged to interact with each other and inspire each other. At the same time, the moderator can steer the conversation in the desired direction [59]. The data obtained in this way is usually more valuable than data from individual interviews [60]. Different perspectives can be recorded, compared, and debated during data collection [61].

It is also recommended that a real-time IRM dashboard be set up. Using this dashboard, both the creator of the role model and all stakeholders involved can track the current status of the role model and recognize trends during the initial creation. Furthermore, such a dashboard is suitable for identifying and reacting to changes at an early stage. It would also be possible for the actors involved to provide feedback and enter queries.

This feedback could, in turn, help develop the role model. Visualization also helps to reduce complexity and build an understanding of the model [62]. This reduction of complexity and, thus, improvement of the model's handling is a research gap in the literature on the IRM [11]. It can help to spread the use of the role model further. A heat map is recommended for visualizing the final matrix with the determined suitability distribution, as this allows suitability focal points and weak points to be quickly identified visually. To further increase the user-friendliness of the model and thus further strengthen acceptance, the stakeholders should also simplify the evaluation process as much as possible. If all institutions and roles are assessed, a large amount of data can quickly be entered. To ensure a high quantity of data with sufficient quality simultaneously, data entry should be made as convenient as possible for the evaluating actors.

5. RESULT

Chapter 5 shows all the results of the previous chapters in the form of an updated IRM matrix. The four dimensions of the matrix were expanded based on the author's suggestions and integrated into the IRM matrices previously existing in the literature in Figure 3. The newly developed role prioritizations (VIR, ER, SR) and the newly proposed economic, technical, and ecological roles can be found on the left-hand side. The upper side contains the temporal dimension, supplemented by the newly proposed software development cycles as examples. Artificial intelligence has been added to the operational dimension on the right-hand side and the institutional dimension at the bottom.

AI contributes its evaluation perspective to the 360° perspective of the operational dimension. It supplements the neutral, self-assessment, and partner assessment with a further view and validates and substantiates the previous perspectives. The AI assessment is based on historical data and can be constantly updated. It helps to identify risk institutions and is continuously learning. In exceptional cases, the AI perspective can replace the other perspectives. Artificial intelligence is permanently listed as a potential role assumer within the institutional dimension. Due to the ever-growing field of artificial intelligence application, it is necessary to check its suitability for various roles and, if required, to have AI take over roles partially or entirely. The least that should be checked concerning an AI role takeover is whether it can provide significant support in executing the role. Furthermore, a visual subdivision according to geographical origin and area of specialization was added to the institutional dimension. This can support the identification of missing institutions and visually validate the selection criteria. The updated matrix in Figure 3 now contains significant changes in all its dimensions and has thus been adapted to the requirements of current cross-border digital projects. It includes optimizations that did not previously exist in the IRM literature, addresses research gaps, and formulates further development potentials of the IRM developers.

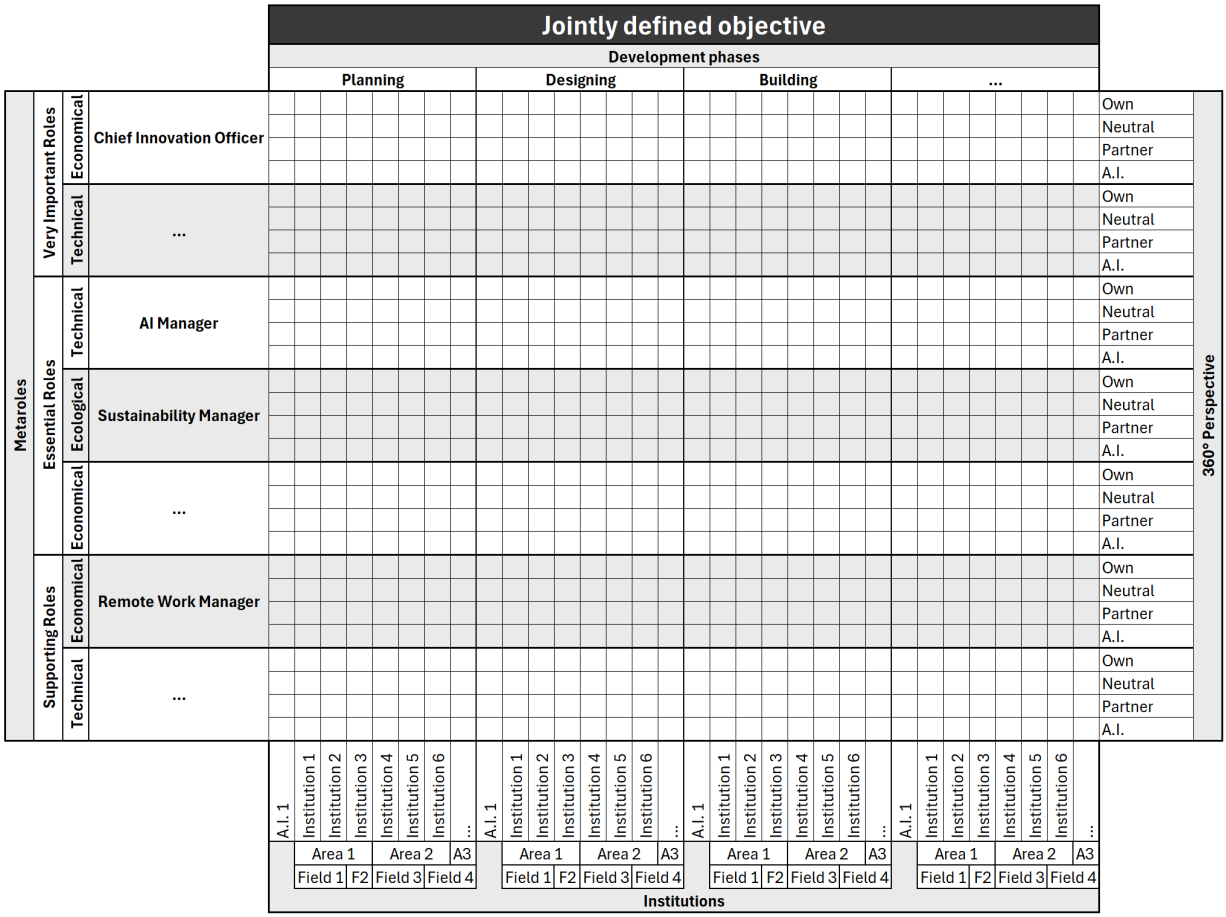

Figure 3. Updated and supplemented matrix

6. CONCLUSIONS

As an economic system architecture, the IRM offers an instrument to enable cooperation in complex environments such as the Gaia-X project lighthouse family 4 Future Mobility. However, the new requirements induced by digitalization and geo-economic changes have not yet been integrated into the IRM literature. The dimensions of IRM were therefore scrutinized and updated. The research question was answered to the extent that an adjustment or update could be identified for each dimension of the IRM. Within the dimension of roles, the roles of Chief Innovation Officer, AI Manager, Sustainability Manager, and Remote Work Manager were included as new roles in the IRM. Furthermore, a new role prioritization was integrated into the IRM, which is used to differentiate between Very Important Roles, Essential Roles, and Supporting Roles. In addition, a new role category, ecological roles, has been integrated into the IRM. The operational dimension has been expanded to include the use of artificial intelligence. This AI is intended to enable a predictive and forecasting analysis based on historical data that complements human perspectives. In the temporal dimension, software development cycles were selected as temporal phases in order to meet the requirements of highly digital projects. In addition, the jointly defined goal was placed concisely above the matrix to keep the goal in sight. In the dimension of institutions, an option for geographical and expertise-specific differentiation was integrated into the IRM. This validates and visually supports the identification of institutions. In addition, artificial intelligence was integrated into the IRM as a fixed institution due to its ever-growing purpose. It is intended to take on roles, support the actors in concentrating on their core tasks, and reduce costs. The aim of the work was to develop and present an updated IRM matrix with all the optimizations.

The work's limitations lie in the novelty of the theoretical model adaptations, which could not yet be empirically verified or falsified. Furthermore, the identified roles are generic and must be modified for specific use cases to meet their requirements.

Future research should also address whether a fixed institution of robotics, analogous to artificial intelligence, should be introduced. Not only is Tesla already planning to use its humanoid robot Optimus Bot in production in 2025 [63], but current research also predicts an increase in the use of robotics in routine roles and thus increased efficiency in these processes [64]. This development will be further driven by improved human-robot interaction [65] so automation through robotics is already finding its way into corporate strategies [66]. Therefore, the author of this paper recommends considering a robotics institution as a potential role assumer in the future.

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NOMENCLATURE

IRM	Institutional Role Model
AI	Artificial Intelligence